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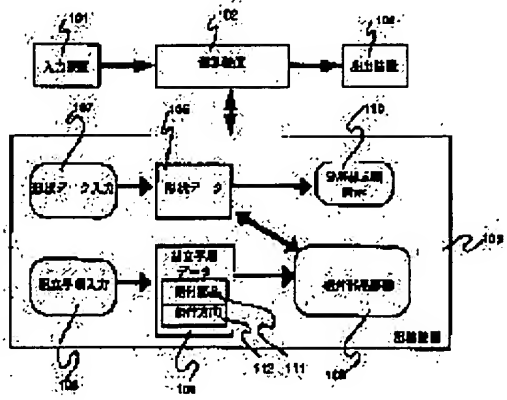
(54) DEVICE AND METHOD FOR PREPARING DISASSEMBLY/ASSEMBLY DRAWING

(57)Abstract:

PURPOSE: To provide a device and method for preparing disassembly/assembly drawing with which the disassembly/assembly drawing of an assembled composite object composed of plural parts can be easily prepared.

CONSTITUTION: This device is provided with an input part 101, shape data memory 105 for storing the shape data of parts consisting of the assembled object, memory 106 for storing assembly process data composed of assembling parts and assembling directions, arithmetic part 102 for displaying the assembled object on a display part based on the shape data, and means 109 for deciding the arranging positions of disassembling parts constituting the assembled object based on the assembly process data and the shape data, and the disassembly/assembly drawing is displayed on the display part corresponding to the decided arranging positions. Thus, the disassembly/assembly drawing can be automatically prepared, and man-hour for preparing the disassembly/assembly drawing can be reduced.



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(54)【発明の名称】　分解組立図作成装置および方法

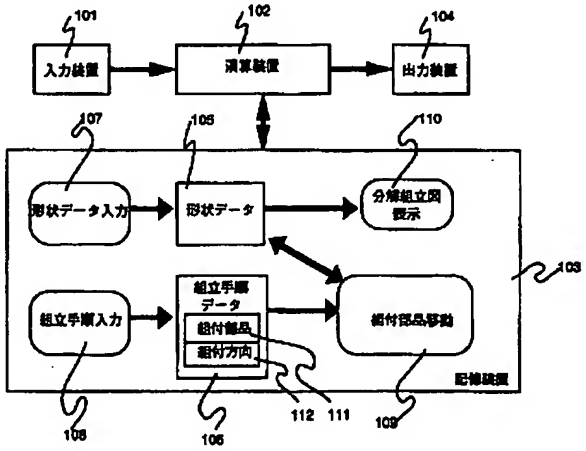
(57)【要約】

【目的】複数の部品からなる組立品の分解組立図の作成を容易に行い得る分解組立図作成装置及び方法の提供。

【構成】入力部１０１と，組立品を構成する部品の形状データを記憶する形状データメモリ１０５と，組付部品と組付方向からなる組立工程データを記憶するメモリ１０６と，前記形状データに基づいて組立品を表示部に表示する演算部１０２と，組立工程データと前記形状データに基づいて、前記組立品を構成する部品の分解状態の配置位置を決定する手段１０９を有し、決定された配置位置に応じて分解組立図を前記表示部に表示する。

【効果】分解組立図の自動作成が可能となり、分解組立図作成の工数を低減することが可能となる。

図　1



【特許請求の範囲】

【請求項１】入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、組立工程データと前記形状データに基づいて、前記組立品を構成する部品の分解状態の配置位置を決定する手段を設け、前記決定された配置位置に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成装置。

【請求項２】請求項１において、前記形状データは、部品を構成する曲線又は曲面の制御点と、部品の頂点であることを特徴とする分解組立図作成装置。

【請求項３】入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、組立工程データと前記形状データに基づいて、前記組立品を構成する部品を分解組立図上で分解状態にする際の前記各部品間の間隔を決定する手段を設け、前記決定された部品間隔に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成装置。

【請求項４】入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、前記部品の形状データから当該部品の形状を包含する多面体を生成する手段と、組立工程データと前記生成された多面体の形状データに基づいて、前記組立品を構成する部品を分解組立図上で分解状態にする際の前記各部品間の間隔を決定する手段を設け、前記決定された部品間隔に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成装置。

【請求項５】入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、前記組立品の分解組立図を表示する場合の視線方向を入力する視線方向入力手段と、組立工程データ，前記形状データ及び前記入力された視線方向データに基づいて、前記組立品を構成する部品を分解組立図上で分解状態にする際の前記各部品間の間隔を決定する手段を設け、前記決定された部品間隔に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成装置。

【請求項６】請求項１乃至５のうちのいずれかにおいて、前記組立工程データは、前記部品の組立順序と組立方向とからなることを特徴とする分解組立図作成装置。

【請求項７】入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、前記部品の組立順序と組立方向とからなる組立工程データを記憶する組立工程データメモリと、前記形状データメモリ内[redacted]品の頂点座標と前記組立工程データメモリ内の組立方向ベクトルとの内積を演算し、その内積値の最小値を求める内積最小値計算手段と、前記部品の頂点座標と前記組立方向ベクトルとの内積を演算し、その内積値の最大値を求める内積最大値計算手段と、前記求められた内積値の最小値と最大値との差分を求め、求めた差分に基づいて、前記組立品を構成する部品を分解組立図上で分解状態にする際の前記各部品間の間隔を決定する手段を設け、前記決定された部品間隔に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成装置。

【請求項８】請求項７において、前記部品間隔決定手段は、前記求めた内積値の最小値と最大値との差分に対し、所定の間隙値を加算又は減算した値を前記各部品間の間隔として決定することを特徴とする分解組立図作成装置。

【請求項９】入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、前記部品の組立順序と組立方向とからなる組立工程データを記憶する組立工程データメモリと、前記形状データメモリ内の部品の形状データから組付け部品の形状を包含する第１の多面体及び被組付け部品の形状を包含する第２の多面体を生成する手段と、前記生成された第１及び第２の多面体の形状データ及び前記組立工程データメモリ内の組立方向ベクトルに基づいて、前記組立品を構成する部品を分解組立図上で分解状態にする際の前記各部品間の間隔を決定する手段を設け、前記決定された部品間隔に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成装置。

【請求項１０】入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、前記部品の組立順序と組立方向とからなる組立工程データを記憶する組立工程データメモリと、前記形状データメモリ内の組付け部品の形状データ及び被組付け部品の形状データに基づいて、組付け部品と被組付け部品との接触面を求める接触面検出手段と、求めた接触面の頂点座標と前記組立工程データメモリ内の組立方向ベクトルとの内積を演算し、その内積値の最小値を求める内積最小値計算手段と、前記組付け部品の頂点座標と前記組立方向ベクトルとの内積を演算し、その内積値の最大値を求める内積最大値計算手段と、前記求められた内積値の最小値と最大値との差分を求め、求めた差分に基づいて、前記組立品を構成する部品を分解組立図上で分解状態にする際の前記各部品間の間隔を決定する手段を設け、前記決定された部品間隔に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成装置。

【請求項１１】入力部と，組立品を構成する部品の形状

データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものであって、前記組立品の分解組立図を作成する方法において、前記形状データメモリより部品の頂点座標を読み出し、部品の組立順序と組立方向とからなる組立工程データを記憶する組立工程データメモリより組立方向ベクトルを読み出し、この読み出された部品の頂点座標と組立方向ベクトルとの内積を演算し、その内積値の最小値を求めると共に、前記読み出された部品の頂点座標と組立方向ベクトルとの内積を演算し、その内積値の最大値を求め、求めた差分に基づいて前記組立品を構成する部品を分解組立図上で分解状態にする際の前記各部品間の間隔を決定し、この決定された部品間隔に応じて分解組立図を前記表示部に表示することを特徴とする分解組立図作成方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、複数の部品から構成される組立品の構造や製造工程における組立手順，保守点検や修理の手順を示す際に作成される、分解組立図を作成する装置および方法に関する。

【０００２】

【従来の技術】分解組立図は、部品を組み合わせた状態から個々の部品をばらし、組付方向と逆の方向に、組立順に配置した図面である。このような分解組立図は、複数の部品から構成される組立品の構成や製造工程における組立手順，保守点検や修理の手順等を示すときに用いられる。従来、分解組立図は、製品の組立図や部品図等の製作図と組立手順等を示した組立手順書を元に手書きで作成していた。また、近年ではＣＡＤシステムが製品設計に用いられ、三次元ＣＡＤシステムを用いて作成した製品の組立モデルを作成し、この三次元ＣＡＤシステムで作成したデータを元にユーザが組立手順を考慮して、移動コマンドによって部品を移動させることによって分解組立図を作成している。

【０００３】

【発明が解決しようとする課題】上記の従来技術では、人手で分解組立図を作成していたために、非常に時間がかかった。また、三次元ＣＡＤシステムで作成した組立品の形状データを利用すれば、少なくとも部品の形状を書く必要はないが、部品を１つ１つオペレータが移動方向と移動量を指示して移動させるために手間がかかった。また、製造準備段階で組立手順を検討している段階では、組立手順が正しいかどうかを形状を見て確認する必要がある。ところが組立手順の決定には試行錯誤を伴い、手順を変更する度に分解組立図を人手で作り直すため工数が非常にかかるという問題が有った。

【０００４】本発明の目的は、組立手順を容易に確認できる分解組立図を容易に作成する装置及び方法を提供することにある。

【０００５】

【課題を解決するための手段】本発明は、入力部と，組立品を構成する部品の形状データを記憶する形状データメモリと，前記形状データに基づいて組立品を表示部に表示する演算部を有するものにおいて、組立工程データと前記形状データに基づいて、前記組立品を構成する部品の分解状態の配置位置を決定する手段を設け、この決定された配置位置に応じて分解組立図を前記表示部に表示するようにしたことに特徴がある。

【０００６】具体的には、前記組立工程データは、部品の組立順序と組立方向とからなり、前記配置位置決定手段は、形状データメモリ内の部品の頂点座標と組立方向ベクトルとの内積を演算し、その内積値の最小値を求めると共に前記読み出された部品の頂点座標と組立方向ベクトルとの内積を演算し、その内積値の最大値を求め、求めた差分に基づいて前記組立品を構成する部品を分解組立図上で分解状態にする際の各部品間の間隔を決定し、この決定された部品間隔に応じて分解組立図を前記表示部に表示するものであります。

【０００７】

【作用】本発明によれば、配置位置決定手段により、形状データメモリ内の部品の頂点座標と組立方向ベクトルとの内積が演算され、その内積値の最小値が求められると共に前記読み出された部品の頂点座標と組立方向ベクトルとの内積が演算され、その内積値の最大値が求められ、求められた差分に基づいて前記組立品を構成する部品を分解組立図上で分解状態にする際の各部品間の間隔が決定され、この決定された部品間隔に応じて分解組立図が表示部に表示されるので、分解組立図の自動作成が可能となり、従来行われていた、部品を１つ１つオペレータが移動方向と移動量を指示して移動させるという作業が不要となり、分解組立図作成の工数を低減することが可能となる。

【０００８】

【実施例】図１に本発明による分解組立図作成装置の構成の一実施例を示す。入力装置１０１は、キーボードやマウス等のユーザからの指示を取り込む機器および通信装置やフロッピーディスク装置等の他の計算機からデータを受け取る装置で構成する。演算装置１０２は、ＣＰＵで構成し、記憶装置１０３に記憶されたプログラムによって記憶装置１０３内のデータを演算したり、入力装置１０１及び出力装置１０４とのデータのやり取りを行う。記憶装置１０３は、ＲＡＭや磁気ディスク等で構成し、プログラム及びデータを記憶する。出力装置１０４は、ＣＲＴ等の表示装置や通信装置やフロッピーディスク装置等の他の計算機へデータを受け渡す機器で構成する。

【０００９】記憶装置１０３には、形状データ１０５，組立手順データ１０６，形状データ入力プログラム１０７，組立手順入力プログラム１０８，組付部品移動プロ

グラム１０９，分解組立図表示プログラム１１０を格納する。形状データ１０５は組立品の幾何情報を記憶する。組立手順データ１０６は、組立の順序毎に組付部品１１１，組付方向１１２を記憶する。形状データ入力プログラム１０７は、入力装置１０１から組立品の幾何情報を取り込み、形状データ１０５に格納する。組立手順入力プログラムは、入力装置１０１から組立の順序毎に、組付部品と組付方向を取り込み、組立手順データ１０６に格納する。組付部品移動プログラム１０９は、ある組立手順ステップにおいて、組付部品１１１の形状データと既に取付済みの部品の形状データと組付方向１１２から、分解組立図上の組付部品位置を計算し、形状データ１０５内の組付部品の部品位置を変更する。分解組立図表示プログラム１１０は、形状データ１０５を出力装置１０４に出力する。

【００１０】形状データ１０５及び組立手順データ１０６の入力は、マウス及びキーボードを用いてユーザが入力するか、他の計算機でデータを作成したデータを、ネットワークやフロッピーディスク等を介して入力する。

【００１１】本実施例における分解組立図作成方法の一例を図４３に示す。処理４３０１では、組立の対象となる部品の形状データ及び組立完了状態における部品の配置位置を取り込む。処理４３０２では、部品の組立順序，組立方向のデータからなる組立手順データを取り込む。処理４３０３では、部品形状，配置位置，組立順序、及び組立方向から、組立品を構成する１つ１つの部品について分解した状態での配置位置を計算する。処理４３０４では、処理４３０３で求めた配置位置に基づいて部品形状を表示する。

【００１２】図２に組付部品移動プログラム１０９の一実施例の詳細な構成を示す。手順順次読みだしプログラム２０１は、組立手順データ１０６内の１つ１つの組立手順ステップを読みだし、組付部品メモリ２０２および組付方向メモリ２０８に格納する。組付方向１１２は、既に組立済みの部品に組付部品を組み付けるときの方向を表すもので、単位ベクトルで表す。これをV_aとする。また、組付済み部品メモリ２０４は、ある組立手順ステップ以前の手順ステップで取り付けた部品のリストを格納するものである。内積最小値計算プログラム２０５は、組付済み部品メモリ２０４から組み付け済み部品のリストを読みだし、それらの部品の頂点と取り付け方向の内積を計算し、その中の最小値を計算する。これをD_{min}とする。内積最大値計算プログラム２０６は、組付部品メモリ２０２より組み付ける部品を読みだし、それらの部品の頂点の座標値を形状データ１０５から取り出す。それらの座標値と組付方向の内積をそれぞれ計算し、その中の最大値を求める。これをD_{max}とする。組付部品位置変更プログラム２０７は、以下の式（１）によって組付部品の移動ベクトルVを求める。ただし、D_{const}はあらかじめ定めた一定量のすきまである。

【００１３】

【数１】

$$V=(D_{min}-D_{max}-D_{const})*V_a \quad \cdots (1)$$

そして、形状データより組付部品の位置M_oを取りだし、移動ベクトルVから求めた移動マトリックスMｖをかけた値Mを新しい部品位置として形状データに書き込む。この計算は以下の式（２）による。

【００１４】

【数２】

$$M=M_v*M_o \quad \cdots (2)$$

組付済み部品追加プログラム２０８は、位置を変更した組付部品を組付済み部品メモリ２０４に追加する。

【００１５】次に、具体的な例を用いて組付部品移動プログラム１０９が分解組立図を作成する原理を説明する。

【００１６】図３は、２つの部品３０１と３０２が組み立てられた状態を示している。部品３０１が組付済み部品，部品３０２が組付部品とする。ベクトル３０３は、部品３０２の組付方向を示している。内積最小値計算プログラム２０５では、組付済み部品３０１の頂点の座標値と組付方向３０３の内積の最小値を求める。図３の例では図４に示すとおり、頂点４０１との内積が最小になりその値は４０２になる。つまり、組付済み部品３０１の形状は、組付方向３０３を数直線として考えると、内積の最小値４０２より大きい領域に存在することになる。一方、内積最大値計算プログラム２０６では、組付部品３０２の頂点の座標値と組付方向303との内積の最大値を求める。図３の例では図４に示すとおり、頂点４０３と組付方向の内積が最大となり、その値は４０４となる。つまり、組付部品３０２の形状は、組付方向３０３を数直線として考えると、内積の最大値４０４より小さい領域に存在することになる。従って、最小値４０２から最大値４０４を引くと、その値は４０５のようになり、４０５の分だけ組付部品を組付方向に移動すると、組付済み部品３０１と組付部品３０２の、組付方向３０３の数直線上でのそれぞれの存在領域が重ならなくなる。しかし、このままでは領域が接しているので、図５のように、４０５の値からあらかじめ定めた一定量５０１を引くと移動量は５０２となる。組付部品３０２を組付方向３０３に移動量５０２だけ平行移動すると、組付済み部３０１と組付部品３０２が分離された分解組立図が得られる。

【００１７】図６に組付部品移動プログラムの処理フローを示す。処理６０１では、組立手順データ内の第１番目の手順ステップの組付部品を組付済み部品とする。処理６０２では、第２番目の手順ステップから最後の手順ステップについて順次、処理６０３～処理６０７を適用する。処理６０３では、現在の手順ステップの組付部品

と組付方向を組付手順データから読みだす。処理６０４では、組付部品のすべての頂点座標を形状データから読みだし、１つ１つの頂点と組付方向の内積を計算し、その値のなかの最大値を求める。処理６０５では、組付済み部品のすべての頂点座標を形状データから読みだし、１つ１つの頂点と組付方向の内積を計算し、その値のなかの最小値を求める。処理６０６では、最小値から最大値を引き、さらに一定量を引いた値に、組付方向をかけてえられるベクトル分だけ組付部品の位置を移動する。処理６０７では、移動して分解状態になった組付部品を組付済み部品に追加する。

【００１８】次に具体的な例を用いて、図６の処理フローによって分解組立図が作成される様子を説明する。図７は説明に用いる組立品の形状を示したものである。組立品の構造は、板７０１に部品７０２がボルト７０３によって固定され、また、部品７０４がボルト７０５によって板７０１に固定されている。部品７０２およびボルト７０３の組付方向は方向ベクトル７０６、また部品７０４およびボルト705の組付方向は方向ベクトル７０７である。

【００１９】図７の組立品の組立手順データは、例えば、図８のようになる。手順ステップ８０１は、組立手順のシーケンス番号であり、この番号順に組立を行う。組付部品８０２は、ある手順ステップにおいて組み付ける部品を表す。図８に示した部品は図７の部品に付けた符号に対応する。組付方向８０３は、ある手順ステップにおける部品の組付方向を表す方向ベクトルである。図８に示した組付方向は、図７の組付方向ベクトルに付けた符号に対応する。なお、第１番目の手順ステップ８０４は、最初に部品を置く場合なので、組付方向を特定する必要はない。

【００２０】まず、処理６０１によって、第１番目の手順ステップ８０４の組付部品７０１を組立済み部品とする。この段階では、図７の組立状態のままである。なお説明上、組付部品と組付済み部品を区別するために、組付済み部品を網かけで、組付部品を斜線のハッチングで示す。図７の状態では、部品７０１が組付済み部品である。次に、処理６０２で、手順ステップ２から５までに処理６０３から６０７を繰り返して適用する。第２番目の手順ステップ８０５に処理６０３を実行すると、組付部品は７０２となる。この状態を図９に示す。処理６０４を実行すると内積の最大値９０１が、処理６０５を実行すると内積の最小値９０２が得られ、処理６０６を実行すると最小値と最大値の差は９０３となり、一定量の隙間を９０４とすると移動ベクトル９０５が得られ、移動後の部品７０２の位置は906になる。処理６０７を実行すると、組付部品であった部品７０２は、９０６の位置で組付済み部品となる。図１０に第３番目の手順ステップ８０６に処理６０３～処理６０７を実行中の様子を示す。組付部品はボルト７０３で、組付方向ベクトルは７０６である。処理６０４を実行すると、組付部品はボルト７０３なので、内積の最大値は１００１になる。処理６０５を実行すると、組付済み部品は部品７０１と部品７０２なので、内積の最小値は１００２になる。１００２から１００１を引いた値１００３が得られ、これから一定値１００４を引いた値1005で、組付部品である７０３を組付方向７０６に移動すると１００６の位置になる。そして、部品７０３は１００６の位置で組付済み部品となる。同様にして第４番目の手順ステップ８０７に処理６０３～処理６０７を実行中の様子を図１１に示す。この場合、内積の最大値と最小値は等しく、図１１の１１０１のようになる。従って、移動量は隙間分の１１０２となる。従って、移動後の部品７０４の位置は１１０３になる。更に、第５番目の手順ステップ８０８に処理６０３～処理６０７を実行中の様子を図１２に示す。組付部品７０５の頂点と組付方向707の内積の最大値は１２０１，組付済み部品７０１～７０４の頂点と組付方向707の内積の最小値は１２０２，最小値と最大値の差は１２０３，隙間を１２０４とすると、移動量は１２０５となる。従って、移動後の部品７０５の位置は1206となる。図１３に処理終了後の形状データの様子を示す。これを表示することにより、分解組立図が得られる。

【００２１】本実施例では、二次元で説明を行ったが、本発明ではこれを三次元でもそのまま実現できる。例えば図１４において、組付部品を１４０１，組付済み部品を１４０２，組付方向を下向き方向の１４０３とする。組付方向１４０３と組付部品１４０１の頂点座標との内積の最大値は１４０４となる。また、組付方向1403と組付済み部品１４０２の頂点座標との内積の最小値は１４０５となる。最小値１４０４から最大値１４０５を引き、さらに隙間分１４０６を引いたもの1407が、組付部品の移動ベクトルとなる。図１５に移動ベクトルによって組付部品1402を移動した後の形状データを示す。

【００２２】また、上記の実施例では、組付部品および被組付部品の頂点と組付方向ベクトルとの内積を計算したが、部品に曲面が含まれる場合は、曲線および曲面の制御点も内積計算の対象とすると、曲面で接する部品のよりわかりやすい分解組立図が作成できる。図１６において、組付部品を１６０１，被組付部品を１６０２とする。組付部品および被組付部品に曲面１６０３が含まれている場合、組付方向ベクトル１６０９との内積計算行う際、頂点１６０７，１６０８の座標と共に、曲面１６０３の制御点１６０５，１６０６も計算の対象とする。その結果、組付部品１６０１の頂点と制御点の座標値と、組付方向ベクトル１６０９との内積の最大値は、頂点１６０８の座標値と方向ベクトル１６０９の内積値１６１０となる。また、被組付部品１６０２の頂点と制御点の座標値と、組付方向ベクトル１６０９との内積の最小値は、制御点１６０５の座標値と方向ベクトル１６０

９の内積値１６１１となる。最小値１６１１と最大値１６１０の差より隙間量1612を引いた値１６１３が組付部品１６０１の移動量となる。図１７に移動後の形状データを示す。このようにして、頂点座標だけでは曲線や曲面を含む部品をすべて分離することができないが、曲線や曲面の制御点を用いることにより、すべての部品を分離した分解組立図を作成することができる。

【００２３】本発明の他の実施例では、部品の形状データの頂点や制御点の代わりに、部品形状を包含する多角形であるバウンディングボックスの頂点を用いる。図１８に本実施例を実現する組付部品移動量計算プログラム１０９の構成を示す。本プログラムは、図２に示した組付部品移動量計算プログラム１０９にバウンディングボックス計算プログラム１８０１を追加したものである。バウンディングボックス計算プログラム１８０１は、形状データ１０５を参照し、部品形状を包含する多角形を求める。内積最小値計算プログラム２０５は、組付済み部品メモリ204に記憶されている部品に対応するバウンディングボックスをバウンディングボックス計算プログラム１８０１から読みだし、１つ１つ頂点座標と組付方向メモリ２０８に記憶されている組付方向ベクトルとの内積を計算し、それらの中から最小値を求める。内積最大値計算プログラム２０６は、組付済み部品メモリ２０４に記憶されている部品に対応するバウンディングボックスをバウンディングボックス計算プログラム１８０１から読みだし、１つ１つの頂点座標と組付方向メモリ２０８に記憶されている組付方向ベクトルとの内積を計算し、それらの中から最大値を計算する。図１８のその他の部分は、図２と同様である。

【００２４】部品形状を包含する多角形であるバウンディングボックスは、例えば図１９に示すような、部品座標系又は組立品座標系の座標軸１９０１に平行な立方体1902である。このようなバウンディングボックスは、部品形状を構成する頂点や制御点の座標値のｘ軸方向の最大値と最小値，ｙ軸方向の最大値と最小値，ｚ軸方向の最大値と最小値をそれぞれ求めることにより計算できる。バウンディングボックスの計算は、移動量を計算する前にあらかじめすべての部品のバウンディングボックスについて行ってもおいてもよいし、移動量計算中に行ってもよい。また、形状データ１０５に含めておいてもよい。このときは、バウンディングボックス計算プログラム１８０１は不要となる。バウンディングボックスは、部品形状を完全に包含しているため、組付部品の移動量は、頂点や制御点の座標を使って計算した移動量より、必ず大きくなるため、すべての部品を分離した分解組立図が作成できる。

【００２５】尚、ここでバウンディングボックスを用いる本実施例について以下に具体的に説明する。図４４は、分解組立図上の部品配置を決定する手順を示すフローチャートである。処理４４０１では、組立の対象となる部品の形状データ及び組立完了状態における部品の配置位置を取り込む。処理４４０２では、部品の組立順序，組立方向のデータからなる組立手順データを取り込む。処理４４０３では、組付済みの部品のリストである被組付部品リストを空にしてから組立手順データの第１番目の組付部品を被組付部品リストにセットする。処理４４０４では、組立手順データの２番目の組付部品から最後の組付部品について組立順序の順に処理４４０５～処理４４０９を繰り返す。処理４４０５では、組付部品のバウンディングボックスを算出する。次に処理４４０６では、被組付部品リストに含まれる部品をすべて包含するバウンディングボックスを算出する。処理４４０７では、組付方向と組付部品のバウンディングボックス、被組付部品のバウンディングボックスから、お互いのバウンディングボックスが隣接するような組付部品の移動量を計算する。処理４４０８では、組付部品を組付方向と反対方向に、処理4407にて求めた移動量だけ移動する。処理４４０９では、移動の終わった組付部品名を被組付部品リストに追加する。

【００２６】図４５に処理４４０７の詳細なフローチャートを示す。処理４５０１では、組付部品のバウンディングボックスの各頂点を始点とし、組付方向の反対方向に延びる半直線を引く。二次元の場合は４本の半直線が引ける。三次元の場合は６本の半直線が引ける。処理４５０２では、処理４５０１で作成した半直線と被組付部品のバウンディングボックスとの交点を求める。１つの半直線が被組付部品のバウンディングボックスと２つの交点を持つときは、始点から遠いほうを交点とする。処理４５０３では、それぞれの半直線について、始点から交点までの距離を算出する。交点がない場合は、距離は０とする。処理４５０４では、処理4503で求めた距離のうち最大値を選択し、それを移動量とする。

【００２７】本実施例による分解組立図作成の実行例を図４６～図４８に示す。図４６は、説明のための組立品の完成状態の図面である。プレート４６０１にボルト4602が固定されている様な構造になっている。ボルト４６０２が組付部品，プレート４６０１が被組付部品で、ボルト４６０２の組付方向が４６０３であるとする。図４７に計算の途中で使われるバウンディングボックス，半直線等の情報を図示しながら処理を説明する。まず、最初に処理４４０５および処理４４０６により被組付部品のバウンディングボックス４７０１および組付部品のバウンディングボックス４７０２を算出する。次に、処理４５０１により、組付部品のバウンディングボックス４７０２の頂点４７０３，４７０４，４７０５，４７０６から組付方向４６０３と反対方向に半直線４７０７，４７０８，４７０９，４７１０を引きだす。次に処理４５０２により半直線４７０７，４７０８，４７０９，4710と被組付部品のバウンディングボックス４７０１の交点４７１１，４７１２，４７１３，４７１４を算出する。

次に処理４５０３により始点と交点の間の距離、つまり、頂点４７０３～交点４７１１，頂点４７０４～交点４７１２，頂点４７０５～交点４７１３，頂点４７０６～交点４７１４を算出する。さらに処理４５０４で始点と交点間の距離のうち最大値、したがって図４７の場合は頂点４７０３～交点４７１１の距離を移動量とする。図４８は、処理４４０８により算出した移動量４８０１で組付部品４６０２を組付方向４６０３と反対方向に移動した状態を示す。このように図４５に示した処理フローにより計算した移動量を用いると、組付部品と被組付部品のバウンディングボックスが重ならない位置に組付部品を配置することができ、したがって、組付部品と被組付部品を分離して部品を配置することができる。これを組立手順の順に適用していけば、組立品全体の分解組立図を自動的に作成することができる。

【００２８】本発明の更に他の実施例を以下に示す。図２０は、図１の分解組立図作成装置において、視線方向入力プログラム２００１を追加すると共に、組付部品移動プログラム１０９を視線方向を考慮した組付部品移動プログラム２００２に、分解組立図表示プログラム１１０を視線方向入力プログラム２００１によって入力された視線方向で表示するようにした分解組立図表示プログラム２００３に変更した機能構成図である。視線方向入力プログラム２００１は、入力装置１０１よりユーザの指示や他のプログラムや計算機からの視線ベクトルを取り込むものである。視線方向を考慮した組付部品移動プログラム２００２は、視線方向入力プログラム２００１から、視線方向ベクトルを受け取り、組立品の形状データ１０５と組立手順データ１０６と視線方向ベクトルから部品の移動量を決定し、形状データ１０５から読みだした部品の位置を変更し、形状データに書き込む。

【００２９】図２１に視線方向を考慮した組付部品移動プログラム２００２の一実施例の構成図を示す。手順順次読みだしプログラム２０１は、組立手順データ１０６内の１つ１つの組立手順ステップを読みだし、組付部品メモリ２０２および組付方向メモリ２０８に格納する。組付方向１１２は、既に組立済みの部品に組付部品を組み付けるときの方向を表すもので、単位ベクトルで表す。これをV_aとする。また、組付済み部品メモリ２０４は、ある組立手順ステップ以前の手順ステップで取り付けた部品のリストを格納するものである。視線方向を法線とする平面への投影プログラム２１０１は、視線方向入力プログラム２００１より視線方向ベクトルV_eを受け取り、また、組付方向メモリ２０８より組付方向ベクトルV_aを読みだし、以下の式（３）によって視線方向V_eを法線ベクトルとする平面への組付方向ベクトルV_aの投影ベクトルV_pを計算する。

【００３０】

【数３】

$$V_p = (V_e \times V_a) / |V_e \times V_a| \times V_e \quad \cdots (3)$$

内積最小値計算プログラム２１０２は、組付済み部品メモリ２０４から取り付け済み部品のリストを読みだし、それらの部品の頂点と投影ベクトルV_pの内積を計算し、その中の最小値を計算する。これをD_{min}とする。内積最大値計算プログラム２１０３は、組付部品メモリ２０２より組み付ける部品を読みだし、それらの部品の頂点の座標値を形状データ１０５から取り出す。それらの点と投影ベクトルV_pの内積を計算し、その中の最大値を求める。これをD_{max}とする。組付部品位置変更プログラム２１０４は、以下の式（４）によって組付部品の移動ベクトルVを求める。ただし、D_{const}はあらかじめ定めた一定量のすきまである。

【００３１】

【数４】

$$V = (D_{min} - D_{max} - D_{const}) * V_a / (V_p \cdot V_a) \quad \cdots (4)$$

そして、形状データ１０５より組付部品の位置M_oを取りだし、移動ベクトルVから求めた移動マトリックスM_vをかけた値Mを新しい部品位置として形状データ１０５に書き込む、この計算は以下の式（２）による。

【００３２】

【数５】

$$M = M_v * M_o \quad \cdots (2)$$

組付済み部品追加プログラム２０８は、位置を変更した組付部品を組付済み部品メモリ２０４に追加する。

【００３３】次に、具体的な例を用いて組付部品移動プログラム２００２が分解組立図を作成する原理を説明する。図２２は、２つの部品２２０１と２２０２が組み立てられた状態を示している。部品２２０１が組付済み部品，部品２２０２が組付部品とする。ベクトル２２０３は、部品２２０２の組付方向V_aを示している。視線方向ベクトルV_eは図２２において紙面に垂直に手前から向こう側への方向とする。図２３は、視線方向ベクトルV_eと組付方向ベクトルV_aに垂直な方向から図２２の組立品を見た図である。ベクトル２３０１は視線方向ベクトルV_eである。図２３の紙面に垂直な方向ベクトルV_tは、視線方向ベクトルV_eと垂直かつ、組付方向ベクトルV_aと垂直であるために、視線方向ベクトルV_eと組付方向ベクトルV_aの外積によって計算されるベクトルを正規化したベクトルである。したがって、V_tは以下の式（５）で求められる。

【００３４】

【数６】

$$V_t = (V_e \times V_a) / |V_e \times V_a| \quad \cdots (5)$$

ただし、V_tは図２３において手前から向こう側へ向かうベクトル２３０２とする。

【００３５】視線方向V_eを[redacted]ベクトルとする平面への組付方向ベクトルV_aの投影ベクトルV_pは、図２３では方向ベクトル２３０３となる。投影ベクトルV_pは、V_tと垂直かつ視線方向V_eと垂直なので、V_tとV_eの外積によって計算されるベクトルである。ただ

$$V_p = V_t \times V_e = (V_e \times V_a) / |V_e \times V_a| \times V_e \quad \cdots (6)$$

内積最小値計算プログラム２１０２では、取付済み部品２２０１の頂点の座標値と投影ベクトル２３０３の内積の最小値を求める。図２２の例では、図２３に示すとおり、頂点２３０４との内積が最小になり、その値は２３０５になる。一方、内積最大値計算プログラム２１０３では、組付部品２２０２の頂点の座標値と投影ベクトル２３０３との内積の最大値を求める。図２２の例では、図２３に示すとおり、頂点２３０６と投影ベクトル２３０３の内積が最大となり、その値は２３０７となる。次に、最小値２３０５から最大値２３０７を引くと、その値は２３０８のようになる。２３０８の値からあらかじめ定めた一定量２３０９を引くと２３１０となる。２３１０は、投影ベクトル上での移動量なので、組付方向２２０３で投影ベクトル２３０３に投影した結果が２３１０となるような移動量を求める必要がある。これは、投影ベクトル２３０３方向の移動量２３１０を投影ベクトル２３０３と組付向ベクトル２２０３の内積で割ればよい。このようにして移動量２３１１は計算できる。組付部品２２０２を組付方向２２０３に移動量２３１１だけ平行移動すると、図２４のようになり、視線方向から見ると図２５で示すように、組付済み部２２０１と組付部品２２０２の重なり部分がない分解組立図が得られる。

【００３７】図２６に視線方向を考慮した組付部品移動プログラムの処理フローを示す。処理２６０１では、視線方向入力プログラムより視線方向ベクトルを取り込む。処理２６０２では、組立手順データ内の第１番目の手順ステップの組付部品を組付済み部品とする。処理２６０３では、第２番目の手順ステップから最後の手順ステップについて順次、処理２６０４～処理２６１０を適用する。処理２６０４では、現在の手順ステップの組付部品と組付方向を組付手順データから読みだす。処理２６０５では、視線方向と組付方向が平行であるかどうかをチェックする、平行な場合は、外積が０となってしまうのでエラーとする。処理２６０６では、投影組付方向V_pを上記の式（６）によって計算する。処理２６０７では、組付部品のすべての頂点座標を形状データから読みだし、１つ１つの頂点と投影組付方向の内積を計算し、その値のなかの最大値を求める。処理２６０８では、組付済み部品のすべての頂点座標を形状データから読みだし、１つ１つの頂点と投影組付方向の内積を計算し、その値のなかの最小値を求める。処理２６０９では、最小値から最大値を引き、さらに一定量を引いた値を組付方向と投影組付方向の内積で割った値に、組付方向をかけてえられるベクトル分だけ組付部品の位置を移動する。移動ベクトルをＶとすると、以下の式（４）で求められる。

【００３８】

$$V = (D_{min} - D_{max} - D_{const}) / (V_p \cdot V_a) * V_a \quad \cdots (4)$$

ただし、D_{min}は、処理２６０８で求めた内積の最小値、D_{max}は、処理2607で求めた内積の最大値、D_{const}は一定量の隙間値、V_aは組付方向ベクトル、V_pは処理２６０６で求めた投影組付方向ベクトル、V_aは処理２６０４で読みだした組付方向ベクトルである。処理２６１０では、移動して分解状態になった組付部品を組付済み部品に追加する。

【００３９】本実施例では、投影ベクトルとの内積計算に頂点の座標値を用いたが、曲面を含む場合には曲面の制御点の座標値も頂点座標値と共に用いてもよい。また、頂点や制御点の代わりに、部品の形状を包含する多面体であるバウンディングボックスの頂点座標を用いても良い。

【００４０】図２７に、図１及び図２における組付部品移動プログラム１０９の更に他の実施例の詳細な構成２７０１を示す。手順順次読みだしプログラム２０１は、組立手順データ１０６内の１つ１つの組立手順ステップを読みだし、組付部品メモリ２０２および組付方向メモリ２０８に格納する。組付方向１１２は、既に組立済みの部品に組付部品を組み付けるときの方向を表すもので、単位ベクトルで表す。これをV_aとする。また、組付済み部品メモリ２０４は、ある組立手順ステップ以前の手順ステップで取り付けた部品のリストを格納するものである。接触面検出プログラム２７０２は、組付部品を組付部品メモリ２０２から読みだし、組付済み部品を組付済み部品メモリ２０４から読みだし、組付部品と組付済み部品の間の接触面を形状データ１０５を参照して検出する。

【００４１】内積最小値計算プログラム２０５は、接触面検出プログラム２７０２より組付部品と組付済み部品の接触面を取り出し、その頂点と取り付け方向の内積を計算し、その中の最小値を計算する。これをD_{min}とする。内積最大値計算プログラム２０６は、組付部品メモリ２０２より組み付ける部品を読みだし、それらの部品の頂点の座標値を形状データ１０５から取り出す。それらの点と組付方向の内積を計算し、その中の最大値を求める。これをD_{max}とする。組付部品位置変更プログラム２０７は、上記の式（１）によって組付部品の移動ベ

クトルVを求める。そして、形状データより組付部品の位置M_0を取りだし、移動ベクトルVから求めた移動マトリックスM_vをかけた値Mを新しい部品位置として形状データに書き込む。この計算は上記の式（2）による。組付済み部品追加プログラム２０８は、位置を変更した組付部品を組付済み部品メモリ２０４に追加する。

【００４２】次に、具体的な例を用いて組付部品移動プログラム１０９が分解組立図を作成する原理を説明する。図２８は、２つの部品２８０１と２８０２が組み立てられた状態を示している。部品２８０１が組付済み部品，部品２８０２が組付部品とする。ベクトル２８０３は、部品２８０２の組付方向を示している。まず、接触面検出プログラム２７０２は、組付済み部品２８０１と組付部品２８０２の間の接触面を検出し、図２９に示すように、ねじの座面２９０１とねじ面２９０２を得る。内積最小値計算プログラム２０５では、面２９０１と面２９０２の頂点の座標値と組付方向２８０３との内積の最小値を求める。図２９の例では、図３０に示すとおり、面２９０１の頂点３００１と方向ベクトル２８０３の内積が最小になり、その値は３００２になる。一方、内積最大値計算プログラム２０６では、組付部品２８０２の頂点の座標値と組付方向２８０３との内積を計算する。図２８の例では、図３０に示すとおり、頂点３００３と組付方向２８０３の内積が最大となり、その値は３００４となる。次に、最小値３００２から最大値3004を引き、さらにあらかじめ定めた一定量３００５を引くと移動量は３００６となる。組付部品２８０２を組付方向２８０３に移動量３００６だけ平行移動すると、図３１のような組付済み部２８０１と組付部品２８０２が分離された分解組立図が得られる。

【００４３】本実施例では、接触面の頂点を内積計算に用いたが、曲面や曲線の制御点も頂点と共に内積計算に用いてもよい。また、接触面の頂点や制御点の代わりに、接触面を包含するバウンディングボックスをあらかじめ求めておき、このバウンディングボックスの頂点を組付方向ベクトルとの内積計算に用いてもよい。さらに、図２１に示した視線方向を考慮した組付部品移動プログラム２００２に接触面検索プログラムを組み込んで、部品の頂点の代わりに接触面の頂点を内積最小値計算に用いてもよい。

【００４４】次に、本発明による更に他の実施例の構成を図３２に示す。図３２は、図２７の接触面検出プログラムを備えた組付部品移動プログラム２７０１に、組付部品の接触面と組付済み部品の接触面の対応を表す対応線を作成する対応線作成プログラム３２０１を追加したものである。図３３と図３４を用いて対応線作成プログラム３２０１の動作を説明する。対応線作成プログラム３２０１は、接触面検出プログラム２７０２より接触面を受け取り、例えばその重心を計算する。図３３の例では、接触面２９０１が接触面検出プログラム２７０２より渡され、重心３３０１が求められる。また、組付部品位置変更プログラム２０７より組付部品の移動ベクトル３００６を受け取り、接触面の重心３３０１を移動ベクトル３００６だけ移動した点３３０２を求める。そして点３３０１と点３３０２の間を結ぶ線分を形状データ１０５に追加する。これを表示すると図３４のように、組付部品の接触面と組付済み部品の接触面の対応を表す対応線３４０１が分解組立図とともに表示できる。対応線３４０１は、図３４では一点鎖線で表したが、形状を表す線と異なる色や線の太さで表示してもよい。

【００４５】これまで述べてきた実施例では、組付部品の移動ベクトルを計算する際に、一定値の隙間D_{const}を用いてきたが、この隙間を視線方向ベクトルと組付方向ベクトルから計算してもよい。

【００４６】図３５は、組付部品と組付済み部品との隙間が一定値の場合と、視線方向ベクトルと組付方向ベクトルから計算する場合の例を示している。視線方向をベクトル３５０１とする。部品３５０２と部品３５０３を組付方向３５０４で組み付けるとすると、隙間は３５０５となる。この場合、組付方向３５０４は視線方向３５０１に垂直なため、視線方向３５０１から見た見かけ上の隙間３５０７は実際の隙間３５０５と等しくなる。ところが、部品３５０８と部品３５０９を組立方向３５１０で組み付ける場合、隙間は３５１１となり３５０５と同じ大きさであるが、視線方向３５０１から見た見掛け上の隙間３５１２は３５０７に比べて小さくなる。見掛け上の隙間が小さくなると、部品同士が近づいてみえて分解組立図としては分かりにくくなってしまう。見掛け上の隙間は、組付方向と視線方向が平行に近づくほど小さくなる。そこで、例えば、隙間D_{const}を次式（7）のように計算する。

【００４７】

【数９】

$$D_{const}=\frac{C}{\sqrt{1-(V_a \cdot V_e)^2}} \quad \cdots (7)$$

【００４８】ただし、V_aは組付方向ベクトル、V_eは視線方向ベクトル、Cは正の定数とする。例えば、図３５における部品３５１３と部品３５１４を組付方向３５１５で組み付ける場合、組付方向３５１５に平行な長さ１のベクトル３５１６の見掛け上の長さ３５１７は、３５１８の長さがV_aとV_eの内積の絶対値となるので上記の式（7）の分母となる。従って、隙間３５１９を、上記の式（7）で計算すれば、組立方向と視線方向の関係によらず見掛け上の隙間３５２０を一定値Cに保つことができる。

【００４９】次に、組立品の構造によっては、１つずつ部品を組み付けることができず、いくつかの部品を組み立てたサブアッセンブリを組み立ててから組み付けなければ組み立てられない場合があるため、以下では、サブアッセンブリがある場合の実施例について説明する。先ず、図４９にこのような組立品の例を示す。図４９に示した組立品は、部品４９０１，４９０２，４９０３の３つの部品からなる。このような組立品の場合、部品４９０１，４９０２，４９０３の順に組み立てることはできない。まず部品４９０１を置いた後、部品４９０２と部品４９０３を組み立てた後、部品４９０１に組み付けなければならない。

【００５０】このような組立品の組立手順データは、例えば、図５０の様に表現できる。部品レベルは、図５１に示すように組立品のサブアッセンブリ関係を木構造で表したときのルート５１０１からの深さを表す。したがって部品４９０１の部品レベルは１、部品４９０２，４９０３の部品レベルは２、部品４９０２と４９０３を組み立てたサブアッセンブリのレベルは１となる。

【００５１】本発明による組立途中にサブアッセンブリがあるような組立順序データから分解組立図を作成する方法の一実施例のフローチャートを図５２に示す。処理5201では、組立品を構成する部品の形状と組立完了状態での部品位置からなる形状データを入力する。処理５２０２では、図５０で示した様な、組立順序，組付部品，組立方向，部品レベルからなる組立手順データを入力する。処理５２０３では、組立手順データの第１番目の組付部品を被組付部品リストに設定する。処理５２０４では、組立手順データの２番目の組付部品から最後の組付部品について順番に処理５２０５以下の処理を適用する。処理５２０５では、組付部品がサブアッセンブリの最初の部品かどうかを判定する。例えば、図５０の様にサブアッセンブリを部品レベルで表す場合、組付部品の部品レベルが１つまえの組付部品の部品レベルより大きい場合、サブアッセンブリの最初の部品となり、処理5205では、yes の方へ分岐し、処理５２０６，５２０７を実行する。部品レベルが同じ場合や前の組付部品のレベルより小さいときは、noの方へ分岐し、処理5208～５２１１を実行する。処理５２０６では、現在の被組付部品リストの内容を被組付部品保存用スタックにプッシュする。処理５２０７では、被組付部品リストを空にした後、現在の組付部品を被組付部品リストに設定する。処理５２０６および処理５２０７により、これまでに組み付けた部品の情報を一時保存し、サブアッセンブリの組立に関する分解組立図を作成する準備が整う。処理５２０８では、分解状態での組付部品の配置位置を組付部品、被組付部品の形状データと組付部品の組付方向から計算する。計算方法はこれまでの実施例で述べた通りである。処理５２０９では、処理５２０８で計算した配置位置に組付部品を配置する。処理５２１０では、現在の組付部品がサブアッセンブリ組立の最後の部品かどうかを判定し、最後の部品であれば処理５２１１に分岐する。現在の組付部品がサブアッセンブリ部品の最後の部品でないときは、ｎｏの方へ分岐し、処理5212に分岐する。例えば、図５０の様にサブアッセンブリを部品レベルで表す場合、現在の組付部品の部品レベルが１つ後の組付部品のレベルより大きいときにサブアッセンブリ組立の最後の部品となる。処理５２１１では、被組付部品保存用スタックに最後にプッシュした被組付部品をポップし、ポップした部品群を現在の被組付部品リストに設定する。処理５２１２では、組付部品を被組付部品リストに追加する。処理５２０４により処理５２０５を組立手順データのすべての組付部品に適用した後、処理５２１３にて移動後の形状データを表示する。これにより分解組立図が表示される。

【００５２】被組付部品保存用のスタックは、例えば図５３の様な、スタックポインタ５３０１と部品名５３０３と部品個数５３０２の欄からなる表で実現する。スタックポインタ５３０１は、現在スタックに格納されている被組付部品リストの数を保存する。あらたに被組付部品リストがプッシュされたら、スタックポインタを１つだけ加算し、加算後のスタックポインタの値をインデックスとした行、この場合は３番目の行５３０４に、部品数と部品名のリストを格納する。逆に、スタックからポップする場合は、スタックポインタ５３０１の値をインデックスとした行の部品名リストをとりだすと共に、その行を表から削除し、スタックポインタ５３０１の値を１つだけ減算する。図５３の例では、スタックポインタ５３０１の値が２なので、二番目の行５３０５から部品名Ｃをとりだし、この行５３０５を削除し、スタックポインタ５３０１の値を１つ減算して１とする。このようにして後から記憶した部品名のリストを最初にとりだすことができる。

【００５３】図５２の処理を図４９のデータおよび図５０の組立手順データに適用したときの分解組立図作成の様子を図を用いて説明する。処理５２０１，５２０２で、形状データ図４９と組立手順データ図５０を入力する。次に、処理５２０３を実行すると、図５０の最初の組立手順データの組付部品４９０１が被組付部品リストに設定される。次の組付部品４９０３について処理５２０５でサブアッセンブリ組立の最初の部品かどうかをチェックする。１つ前の組付部品４９０１のレベルは１であるが、現在の組付部品４９０３の部品レベルは２で、現在の組付部品の部品レベルの方が大きいので、サブアッセンブリ組立の最初であることがわかる。そこで、処理５２０６により被組付部品リストの内容、この場合は４９０１を被組付部品用スタックに格納する。そして、処理５２０７により現在の組付部品４９０３を被組付部品とする。この後、処理５２０４にてループし、組付部品４９０２に処理５２０５以下を適用する。まず、処理

５２０５にてサブアッセンブリ組立の最初であるかをチェックする。１つまえの組付部品４９０３の部品レベルと現在の組付部品４９０２の部品レベルは共に２で同一である。したがってサブアッセンブリ組立の最初の部品ではないのでｎｏに分岐し、処理５２０８に進む。ここで、組付部品４９０２と被組付部品４９０３の形状データと組付部品4902の組立方向データを用いて、分解状態の配置位置を計算する。その計算結果に基づいて処理５２０９にて４９０２を移動した状態を図５４に示す。次に処理5210にてサブアッセンブリ組立の最後であるかを調べる。部品４９０２の部品レベルが２で、次の組付部品４９０２＋４９０３の部品レベルが１なのでサブアッセンブリ組立の最後の部品である。したがってyes の方へ分岐し、被組付部品スタックから部品４９０１をポップし、被組付部品リストにセットする。この後、処理５２０４にてループし、組付部品４９０２＋４９０３に処理５２０５以下を適用する。組付部品４９０２＋４９０３とは、２つの部品４９０２と４９０３を組み立てて組み付けることを示している。処理５２０５では、部品４９０２＋4903の部品レベルは１で、１つ前の組付部品４９０２の部品レベルは２であり、サブアッセンブリ組立の最初の部品ではない。したがって、noに分岐し、処理５２０８に進む。ここでは、前のループで計算した分解状態の４９０２と４９０３の位置および形状データを組付部品、部品４９０１を被組付部品として４９０２と4903を分解した状態の位置を求め、処理５２０９で４９０２と４９０３を移動する。この状態を図５５に示す。以上の様にして、サブアッセンブリ組立のある組立手順データの分解組立図を作成することができる。

【００５４】サブアッセンブリ組立のある組立手順データとして、図５０の様に部品レベルによりサブアッセンブリを表現する実施例を示したが、図５６の様に組立手順データにサブアッセンブリ組立の有無を示すフラグを設け、フラグが０のときは、サブアッセンブリ組立なし、１のときはサブアッセンブリ組立ありとしてもよい。サブアッセンブリ組立の組立手順は図５７のように別の組立手順データを用意して表現する。図５６のサブアッセンブリ組立付の組付部品４９０４とサブアッセンブリ組立の組立手順データとの対応は、組立手順データにサブアッセンブリ名を記憶しておくことにより、組付部品名とサブアッセンブリ名の一致を調べることにより、対応をとることができる。このような組立手順データの表現のときは、サブアッセンブリ組立の最初かどうかの判定は、サブアッセンブリフラグが１である場合となる。また、組付部品名と同じサブアッセンブリ名である組立手順データを検索し、その最初の組付部品を新しい被組付部品とする。サブアッセンブリ組立の最後かどうかの判定は、組立順データの最後まで到達したかによって判断する。

【００５５】次に具体的な例を用いて、図１に示した分解組立図作成装置により、組立品の組立手順を作成する様子を示す。図３６は、説明に用いる組立品の構造である。組立品は、部品３６０１，部品３６０２，部品３６０３，部品３６０４から構成されている。図３７にユーザが入力した組立手順の一例を示す。これは、最初に部品３６０１を置き、次に部品３６０２を上方から取り付け、次に部品3603を横から取り付け、最後に部品３６０４を上方から取り付けるというものである。これを本発明による分解組立図作成装置によって分解組立図を作成すると図３７のようになる。図３７を見たユーザは、部品３６０３を横から取り付けようとするが部品３６０１が邪魔になって取り付けられないことが解かる。部品３６０３は部品３６０１に上方からしか取り付けられないので、ユーザは組立手順入力プログラム１０８に指示を与えて、図３９の組立手順のように部品３６０３の取り付け方向３９０１を上方からの取り付けに変更する。図３９の組立手順を元に組付部品移動プログラム１０９を起動によって分解組立図を作成し、分解組立図表示プログラム１１０で表示すると、図４０のようになる。図４０を見ると、ユーザは部品３６０２を取り付けてから部品３６０３を取り付けているため、部品３６０２が邪魔になって部品３６０３が取り付けられないことが解かる。そこでユーザは組立手順入力プログラム１０８に指示を与えて、図４１の組立手順のように部品３６０３の組付手順ステップ４１０１を部品３６０２の組立手順ステップ４１０２の前に変更する。図４１の組立手順を元に組付部品移動プログラム１０９を起動によって分解組立図を作成し、分解組立図表示プログラム１１０で表示すると、図４２のようになる。図４２を見ると、組立途中で部品がぶつかったりするような不具合がないことが解かる。このようにして、組立手順を入力し、分解組立図を作成することを繰り返すことによって正しい組立手順が得られる。

【００５６】尚、ここで更に本発明による分解組立図を用いた組立手順の変更方法の一例を図５８に示す。処理５８０１では、分解組立図を作成する組立品を構成する部品の形状および組立完了状態での部品位置からなる形状データを入力する。処理５８０２では、組立順序，組付部品，組立方向からなる組立手順データを入力する。処理５８０３では、組立形状データと組立手順データから分解状態の部品位置を算出する。処理５８０４では、処理５８０３で算出した分解状態での部品位置に部品形状を表示し、分解組立図として表示する。処理５８０５では、ユーザに組立手順の変更があるかどうかを問い合わせる。ユーザはキーボードやマウス等の入力機器を用いて変更の必要の有無を入力する。変更の必要がない場合は、手順変更処理を終了する。変更が必要なときは、処理５８０６を実行する。処理５８０６では、手順変更の指示をユーザに問い合わせる。ユーザは、変更が必要な部品と変更内容をキーボードやマウスを用いて入力す

る。複数の変更対象の部品を指[redacted]し、処理５８０７では、ユーザが入力した変更指示に基づいて組立手順データを変更する。変更指示としては、例えば２つの部品を指定してその部品の組立順序を入れ替える指示がある。また、別な例としては、変更対象の部品を複数、順次指示したあと、別に指定した部品の前又は後に指示した順に手順を挿入する指示がある。

【００５７】図５９～図６３に図５８で示した組立順序編集方法の実行例を示す。図５９は、処理５８０１で入力される形状データの例である。この例では、組立品は、部品５９０１，５９０２，５９０３，５９０４の４つの部品からなる。図６０は、処理５８０２で入力される組立手順データの例である。この組立手順データは、まず部品５９０１を置き、次に部品５９０２を－Ｙ軸方向から組み付け、次に部品５９０３を－Ｙ軸方向から組み付け、最後に部品５９０４を－Ｙ方向から組み付ける組立手順を表している。図６１は、処理５８０１および処理５８０４によって生成された分解組立図である。処理５８０５により組立手順変更メニュー６１０１が表示され、ユーザは例えばマウスで入れ替えコマンド６１０２を選択する。これにより処理５８０６に制御が移り、変更指示を入力する。例えば入れ替えコマンドの場合、２つの部品５９０３と部品５９０４を指示する。そうすると、処理５８０７により組立手順データ内の部品５９０２と部品５９０３の順序を入れ替える。図６２に変更後の組立手順データを示す。変更後の組立手順データと処理５８０１で入力した形状データを用いて処理５８０３で配置位置を計算し、処理５８０４で表示した結果は、図６３の様になる。変更後の分解組立図を表示後、再び処理５８０５により組立手順変更メニュー６１０１が表示される。ここで、ユーザは移動コマンド６１０３を選択すると、処理５８０６により変更指示を入力する。移動コマンドの場合には、順序移動対象の部品、移動先の部品を分解組立図上で指示し、移動先部品の前に移動するか後に移動するかをメニューで指示する。例えば図６３上で、順序変更部品として部品５９０３と部品5904の順で指示し、次に移動先部品として５９０２を指示する。そして、メニュー６３０１より「前に」を選択する。処理５８０７では、処理５８０６で入力された変更指示に従い、部品５９０３と部品５９０４をこの順で部品５９０２の前に移動し、その結果、図６４の様な組立手順データが得られる。図６４の組立手順データと図５９の形状データおよび配置データをもとに、処理５８０３で配置位置を計算し、処理５８０４で表示すると図６５のような分解組立図が得られる。処理５８０５にてメニュー６１０１を表示し、ユーザがこれ以上組立順序を変更する必要がないときは終了６１０４を選択して編集処理を終了する。

【００５８】このようにして、分解組立図上で組立手順を指示すると、部品が分解されているので部品の指示が容易になると共に、分[redacted]立図上では、組立順序の順に部品が並んでいるので、部品の組立順序の把握が容易になる。したがって、組立完了状態で順序を変更するよりも、分解組立図上で組立順序の変更をするほうが容易である。

【００５９】以上、本発明の実施例によれば、少なくとも形状データと組立手順データがあれば、分解組立図を自動的作成できるため、分解組立図作成の工数を低減する効果がある。

【００６０】また、部品形状の頂点や制御点の代わりに、部品形状を包含するバウンディングボックスの頂点を用いることにより、１つの部品について高々６つの頂点と組付方向ベクトルとの内積を計算するだけですむので、高速に分解組立図を作成できるという効果がある。

【００６１】更にまた、組付部品の移動量計算に分解組立図の視線方向を用いることにより分解組立図においてばらした部品同士が見かけ上重なりのない図を作成できるので、理解しやすい分解組立図を作成できるという効果がある。

【００６２】また、組付部品の移動量計算に分解組立図の視線方向をもちいることにより分解組立図においてばらした部品同士を見かけ上、等間隔に配置した図を作成できるので、理解しやすい分解組立図を作成できるという効果がある。

【００６３】また、組立状態で接触する面を分解組立図上で線で結ぶことができるので、組立方向が理解しやすい分解組立図を作成できるという効果がある。

【００６４】また、分解組立図を容易に作成できるので、組立手順データを入力してその分解組立図を表示させ、それを見て組立手順の不具合を見つけ、組立手順データを修正するというような作業が少ない手間で可能となり、製品の製造工程での組立手順の立案が容易になるという効果がある。

【００６５】

【発明の効果】本発明によれば、分解組立図の自動作成が可能となり、従来行われていた、部品を１つ１つオペレータが移動方向と移動量を指示して移動させるという作業が不要となり、分解組立図作成の工数を低減することが可能となる。

【図面の簡単な説明】

【図１】本発明の一実施例である分解組立図作成装置の構成図である。

【図２】図１の実施例における組付部品移動部の詳細構成図である。

【図３】組立品の状態図である。

【図４】図２に示す組付部品移動部の動作原理を説明する図である。

【図５】図２に示す組付部品移動部の動作原理を説明する図である。

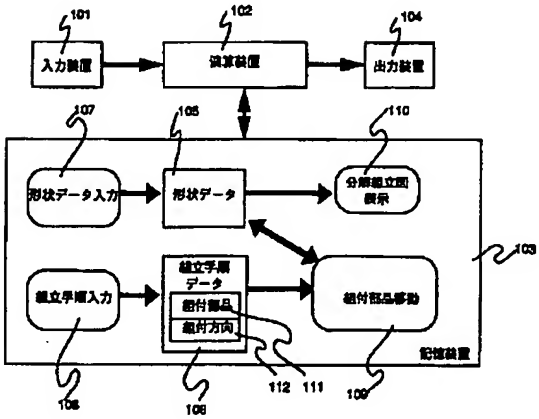
【図６】組付部品移動部の処理手順を表す図である。

【図７】他の組立品の状態図である。
【図８】組立手順データのデータ構成を表す図である。
【図９】図７に示す組立品に対する組付部品移動部の動作を説明する図である。
【図１０】図７に示す組立品に対する組付部品移動部の動作を説明する図である。
【図１１】図７に示す組立品に対する組付部品移動部の動作を説明する図である。
【図１２】図７に示す組立品に対する組付部品移動部の動作を説明する図である。
【図１３】図７に示す組立品に対し本発明の一実施例によって作成した分解組立図である。
【図１４】三次元形状の組立品に対する組付部品移動部の動作を説明する図である。
【図１５】本発明の一実施例によって作成した三次元形状データに基づく分解組立図である。
【図１６】組付部品移動部の一実施例の動作を説明する図である。
【図１７】図１６に示す本発明の一実施例によって作成した分解組立図である。
【図１８】本発明の他の実施例である分解組立図作成装置の組付部品移動部の詳細構成図である。
【図１９】部品形状を包含するバウンディングボックスの一例を表す図である。
【図２０】本発明の他の実施例である分解組立図作成装置の構成図である。
【図２１】図２０に示す組付部品移動部の詳細構成図である。
【図２２】組立品の状態図である。
【図２３】図２２に示す組付部品移動部の動作を説明する図である。
【図２４】図２２に示す組付部品移動部の動作を説明する図である。
【図２５】本発明の一実施例によって作成した分解組立図である。
【図２６】図２２に示す組付部品移動部の処理手順を表す図である。
【図２７】本発明の他の実施例である分解組立図作成装置の組付部品移動部の詳細構成図である。
【図２８】組立品の状態図である。
【図２９】組立品の接触面の例を表す図である。
【図３０】図２７に示す組付部品移動部の動作を説明する図である。
【図３１】本発明の一実施例によって作成した分解組立図である。
【図３２】本発明の他の実施例である分解組立図作成装置の組付部品移動部の詳細構成図である。
【図３３】接触面の対応線を作成する原理を説明する図である。
【図３４】本発明の一実施例によって作成した対応線を含む分解組立図である。
【図３５】視線方向により、部品間の隙間を決定する方法の原理を説明する図である。
【図３６】組立品の状態図である。
【図３７】組立手順データのデータ構成を表す図である。
【図３８】本発明の一実施例の装置によって作成した分解組立図である。
【図３９】組立手順データのデータ構成を表す図である。
【図４０】本発明の一実施例の装置によって作成した分解組立図である。
【図４１】組立手順データのデータ構成を表す図である。
【図４２】本発明の一実施例の装置によって作成した分解組立図である。
【図４３】本発明の一実施例である分解組立図作成方法の処理フロー図である。
【図４４】図１８に示す実施例の分解組立図作成方法の処理フロー図である。
【図４５】図４４のステップ４４０７の詳細フロー図である。
【図４６】組付品の状態図である。
【図４７】組付品に対しバウンディングボックス及び半直線が付加された図である。
【図４８】配置位置決定後の状態を表す図である。
【図４９】サブアッセンブリ組立のある組立品の形状データを示す図である。
【図５０】サブアッセンブリ組立のある組立手順データのデータ構成図である。
【図５１】木構造により組立品を表現した図である。
【図５２】本発明の他の実施例であるサブアッセンブリ組立に対応した分解組立図作成方法の処理手順を表す図である。
【図５３】被組付部品用スタックのデータ構成図である。
【図５４】分解組立図作成の途中状態を表す図である。
【図５５】分解組立図作成の最終状態を表す図である。
【図５６】サブアッセンブリ組立のある組立手順データのデータ構成図である。
【図５７】サブアッセンブリ組立のある組立手順データのデータ構成図である。
【図５８】本発明の他の実施例である分解組立図上での組立手順の編集を行う際の処理手順を表す図である。
【図５９】組立品の状態図である。
【図６０】組立手順データのデータ構成図である。
【図６１】分解組立図上での組立手順編集の指示方法を説明する図である。
【図６２】組立手順編集後の組立手順データのデータ構成図である。

【図６３】組立手順編集後の分解組立図である。
【図６４】組立手順編集後の組立手順データのデータ構成図である。
【図６５】組立手順編集後の分解組立図である。
【符号の説明】
１０１…入力装置、１０２…演算装置、１０３…記憶装置、１０４…出力装置、１０５…形状データ、１０６…組立手順データ、１０７…形状データ入力プログラム、１０８…組立手順入力プログラム、１０９…組付部品移動プログラム、１１０…分解組立図表示プログラム、１１１…組付部品データ、１１２…組付方向データ。

【図１】

図 1



【図２】

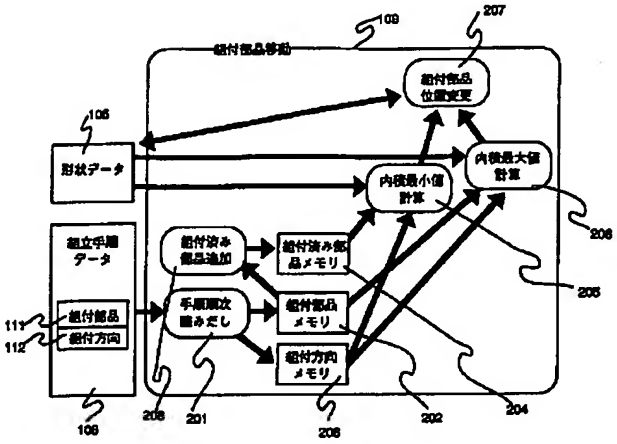
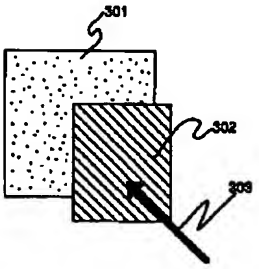


図２

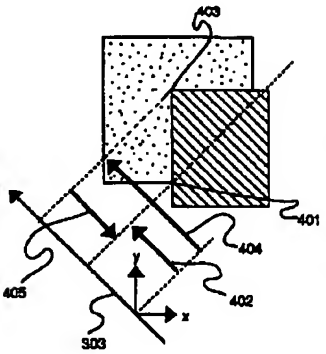
【図３】

図 3



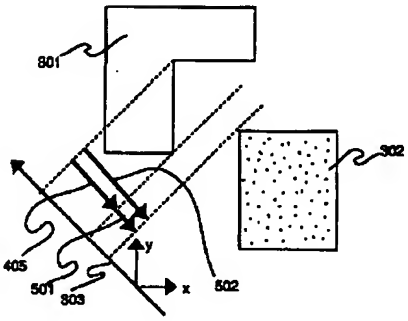
【図４】

図 4



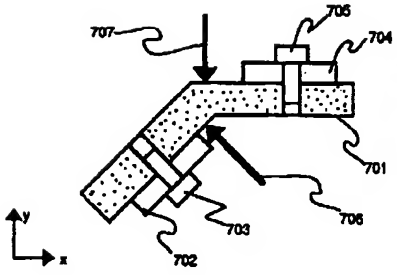
【図５】

図 5



【図７】

図 7



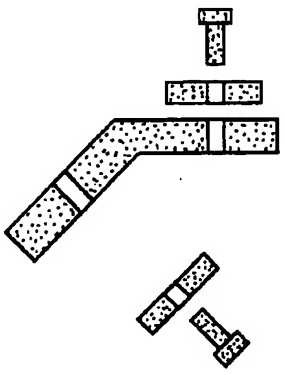
【図８】

図 8

	801 手順ステップ	802 組付部品	803 組付方向
804	1	701	—
805	2	702	708
806	3	703	708
807	4	704	707
808	5	705	707

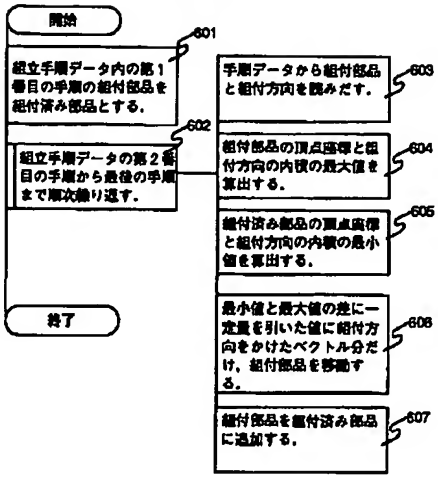
【図１３】

図 13



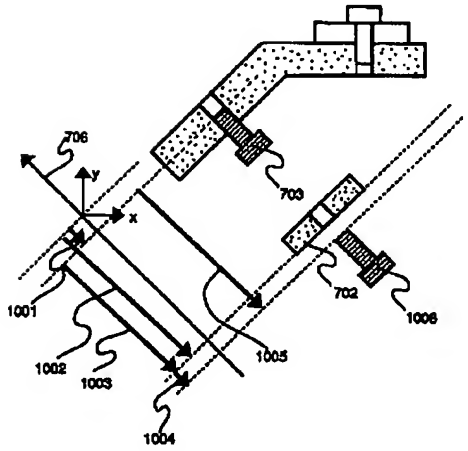
【図６】

図 6



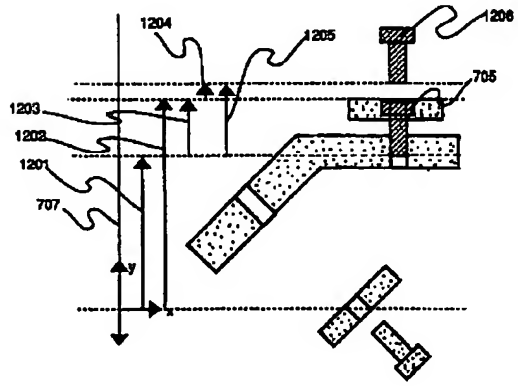
【図１０】

図 10



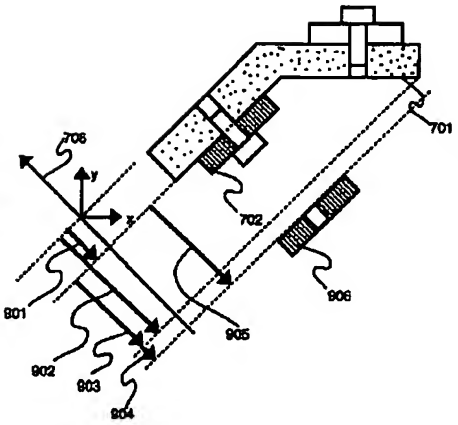
【図１２】

図 12



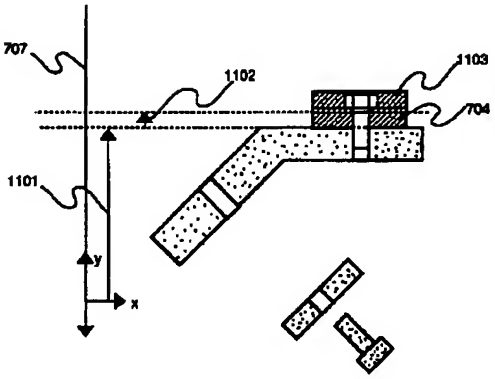
【図９】

図 9



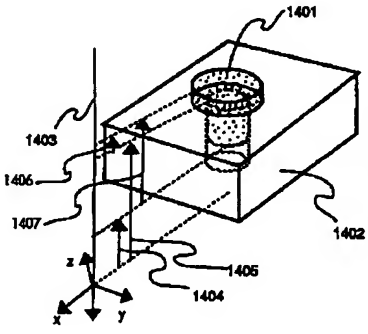
【図１１】

図 11



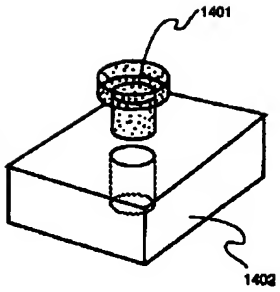
【図１４】

図 14



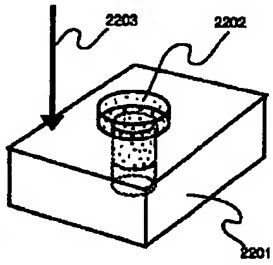
【図１５】

図 15



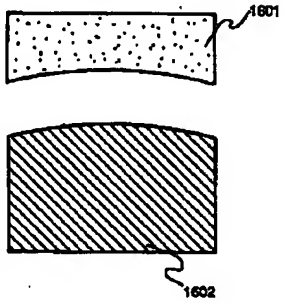
【図２２】

図 22



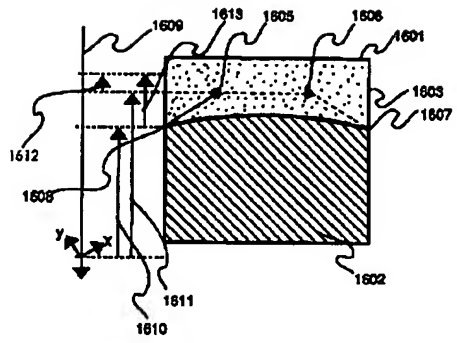
【図１７】

図 17



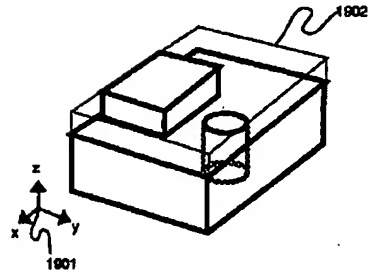
【図１６】

図 16

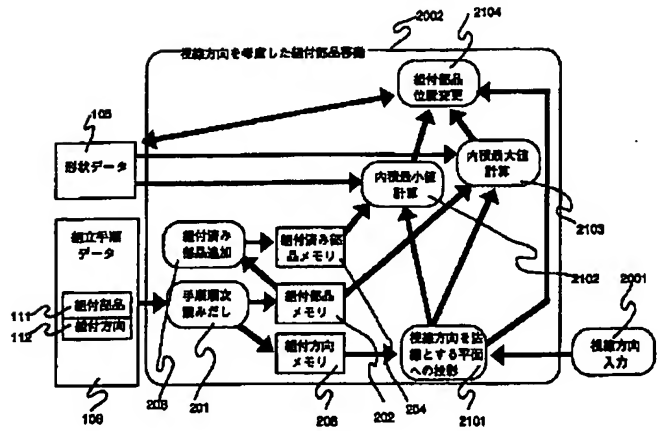


【図１９】

図 19

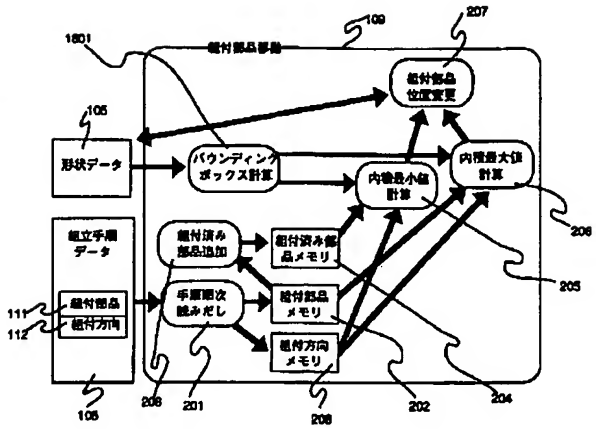


【図２１】



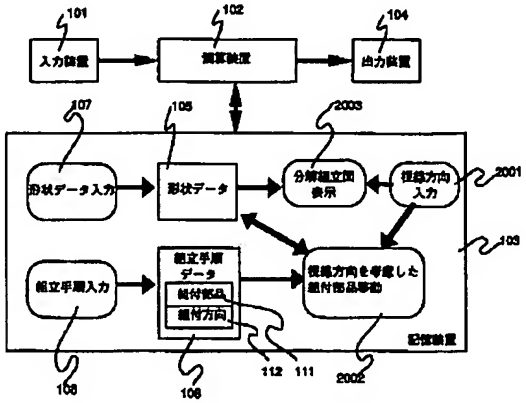
【図１８】

図 18



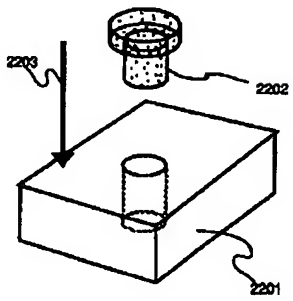
【図２０】

図 20



【図２５】

図 25



【図２３】

図 23

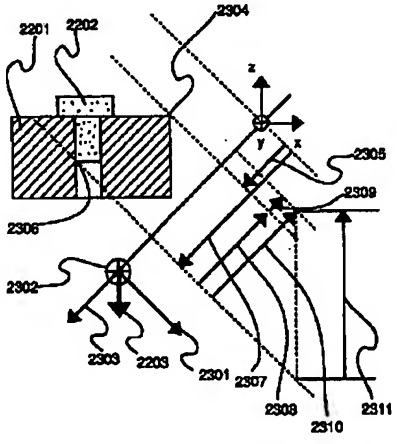
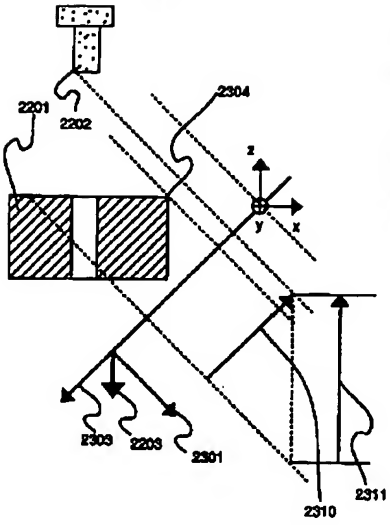


図 21

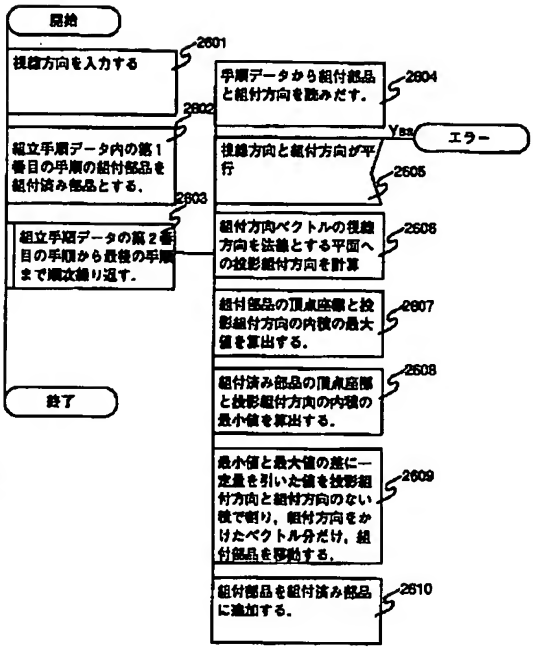
【図２４】

図 24



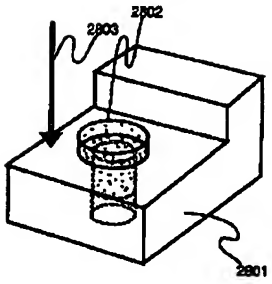
【図２６】

図 26



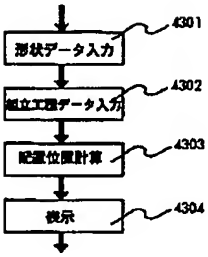
【図２８】

図 28



【図４３】

図 43



【図２７】

【図２９】

【図３７】

図 37

手順ステップ	組付部品	組付方向
1	3601	—
2	3602	(0,-1)
3	3603	(-1,0)
4	3604	(0,-1)

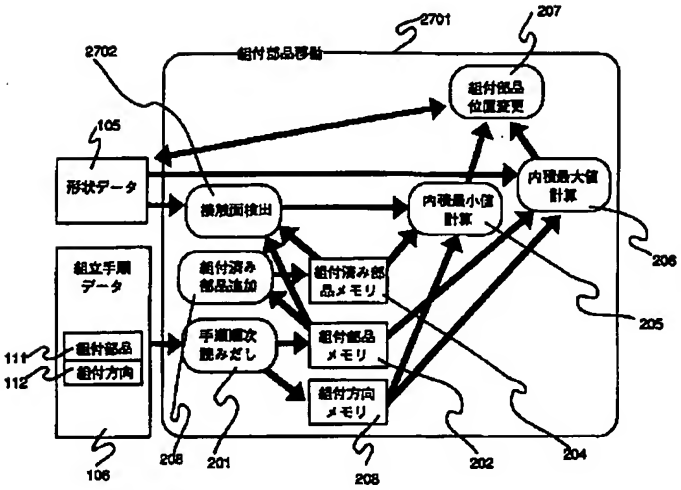
【図３９】

図 39

手順ステップ	組付部品	組付方向
1	3601	—
2	3602	(0,-1)
3	3603	(0,-1)
4	3604	(0,-1)

3901

図 29



【図３１】

図 27

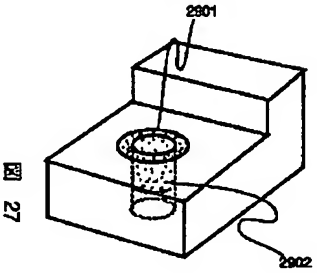
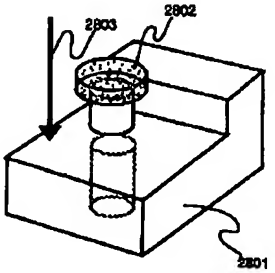
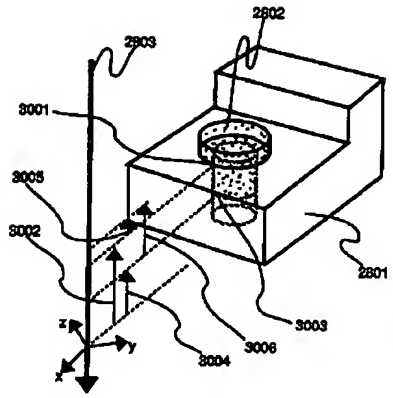


図 31



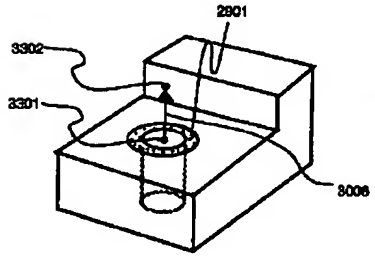
【図３０】

図 30

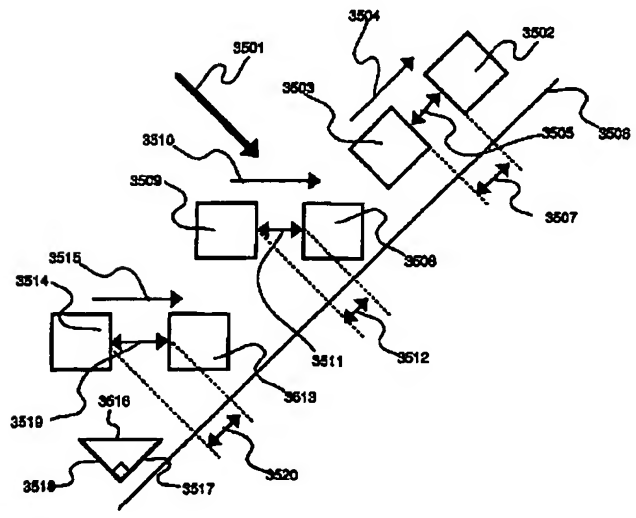


【図３３】

図 33



【図３５】



【図３２】

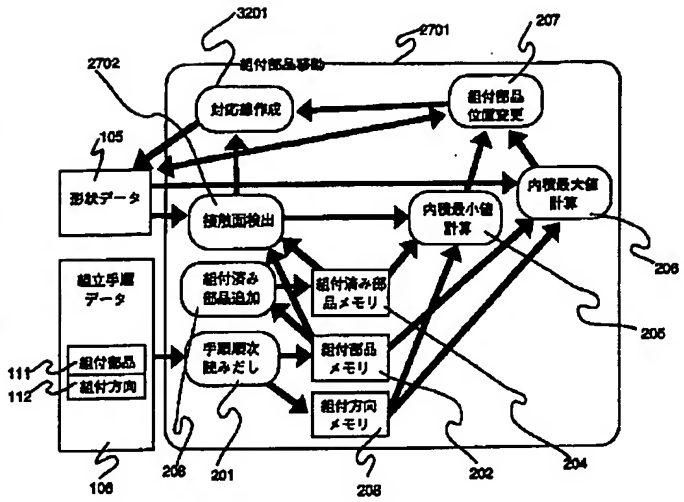
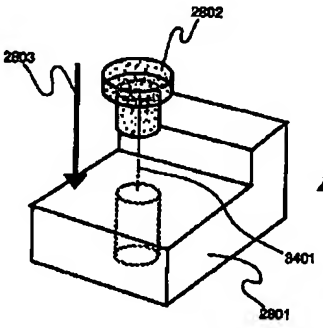


図 32

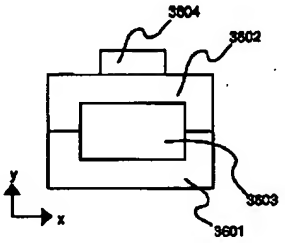
【図３４】

図 34



【図３６】

図 36



【図３８】

図 38

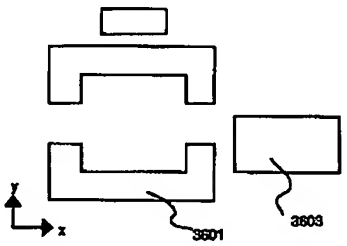
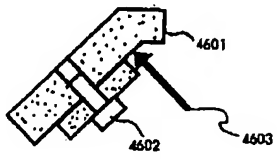


図 35

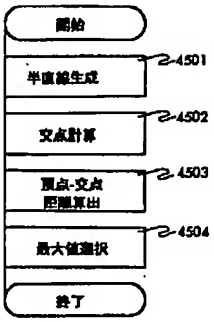
【図４６】

図 46



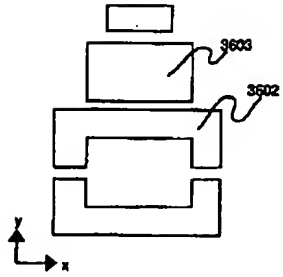
【図４５】

図 45



【図４０】

図 40



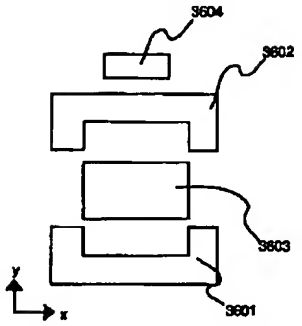
【図４１】

図 41

手順ステップ	組付部品	組付方向	
1	3601	—	
2	3603	(0, -1)	4101
3	3602	(0, -1)	4102
4	3604	(0, -1)	

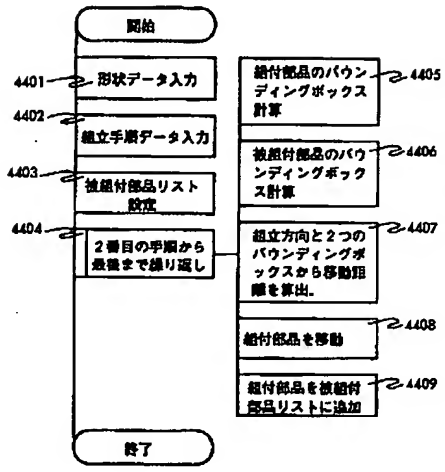
【図４２】

図 42



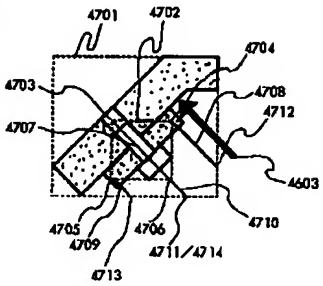
【図４４】

図 44



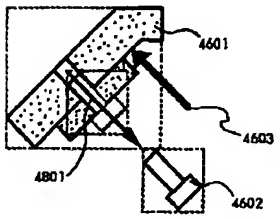
【図４７】

図 47



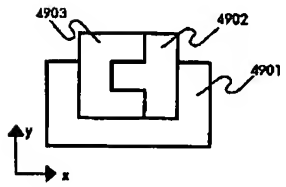
【図４８】

図 48



【図４９】

図 49



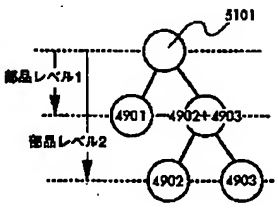
【図５０】

図 50

順序	組付部品	組付方向	部品レベル
1	4901		1
2	4903		2
3	4902	-X	2
4	4902+4903	-Y	1

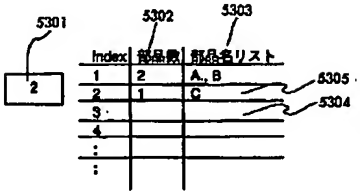
【図５１】

図 51



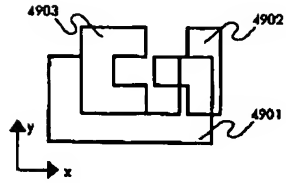
【図５３】

図 53



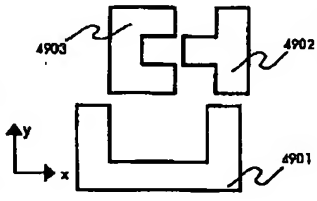
【図５４】

図 54



【図５５】

図 55



【図５６】

図 56

順序	組付部品	組付方向	サブアッセンブリフラグ
1	4901		0
2	4904	-Y	1

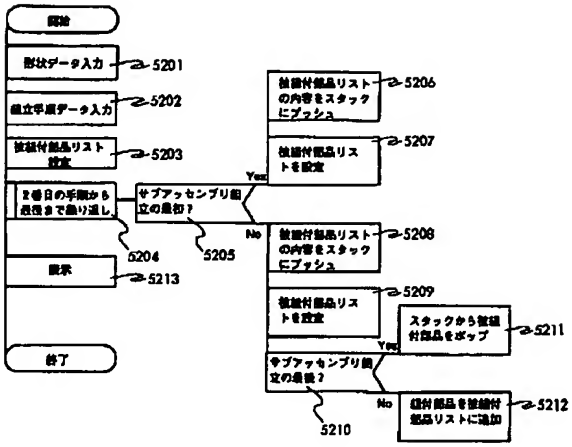
【図５７】

図 57

順序	組付部品	組付方向	サブアッセンブリフラグ
1	4903		0
2	4902	-X	0

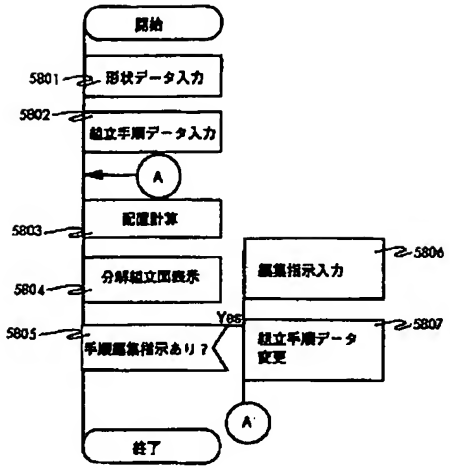
【図５２】

図 52



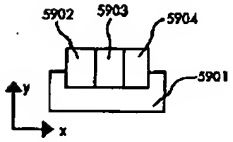
【図５８】

図 58



【図５９】

図 59



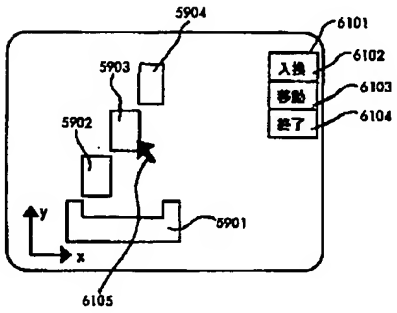
【図６０】

図 60

順序	組付部品	組付方向
1	5901	-Y
2	5902	-Y
3	5903	-Y
4	5904	-Y

【図６１】

図 61



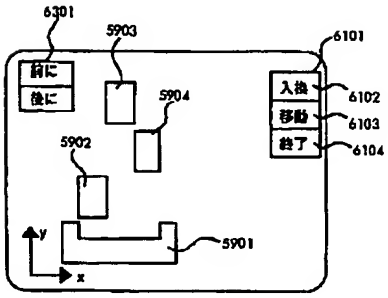
【図６２】

図 62

順序	組付部品	組付方向
1	5901	-Y
2	5902	-Y
3	5904	-Y
4	5903	-Y

【図６３】

図 63



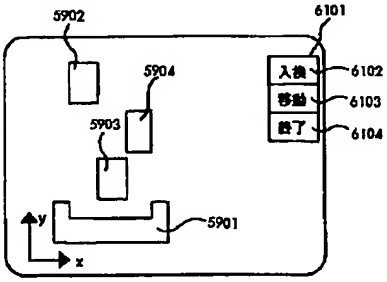
【図６４】

図 64

順序	組付部品	組付方向
1	5901	-Y
2	5903	-Y
3	5904	-Y
4	5902	-Y

【図６５】

図 65



* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The exploded view listing device characterized by to establish a means to by_which an erector determines the arrangement location of the decomposition condition of the components which constitute said assembly based on data and said configuration data in what has the operation part which displays an assembly on a display based on said configuration data as the input section and the configuration data memory which memorize the configuration data of the components which constitute an assembly, and to display an exploded view on said display according to said determined arrangement location.
[Claim 2] It is the exploded view listing device characterized by being the control point of the curve or curved surface where said configuration data constitute components in claim 1, and the top-most vertices of components.
[Claim 3] In what has the operation part which displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components which constitute an assembly based on said configuration data The exploded view listing device characterized by establishing a means by which an erector determines spacing between said each part articles at the time of changing into a decomposition condition the components which constitute said assembly on an exploded view based on data and said configuration data, and displaying an exploded view on said display according to said determined components spacing.
[Claim 4] In what has the operation part which displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components which constitute an assembly based on said configuration data A means to generate the polyhedron which includes the configuration of the component concerned from the configuration data of said component, A means by which an erector determines spacing between said each part articles at the time of changing into a decomposition condition the components which constitute said assembly on an exploded view based on data and said generated configuration data of a polyhedron is established. The exploded view listing device characterized by displaying an exploded view on said display according to said determined components spacing.
[Claim 5] In what has the operation part which displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components which constitute an assembly based on said configuration data A direction input means of a look to input the direction of a look in the case of displaying the exploded view of said assembly, An erector is based on data, said configuration data, and said inputted direction data of a look. The exploded view listing device characterized by establishing a means to determine spacing between said each part articles at the time of changing into a decomposition condition the components which constitute said assembly on an exploded view, and displaying an exploded view on said display according to said determined components spacing.
[Claim 6] It is the exploded view listing device characterized by the assembly sequence of said component, and data consisting of assembly like said erector in claim 1 thru/or either of 5.
[Claim 7] In what has the operation part which displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components which constitute an assembly based on said configuration data The erector the erector who consists [the assembly sequence of

said component and] of assembly remembers data to be Data memory, An inner product minimum value count means by which the top-most-vertices coordinate and said erector of components in said configuration data memory calculate an inner product with the direction vector of assembly in data memory, and calculate the minimum value of the inner product value, An inner product maximum count means to calculate the inner product of the top-most-vertices coordinate of said component, and said direction vector of assembly, and to calculate the maximum of the inner product value, Ask for the difference of said minimum value of an inner product value and maximum which were calculated, and it is based on the difference for which it asked. The exploded view listing device characterized by establishing a means to determine spacing between said each part articles at the time of changing into a decomposition condition the components which constitute said assembly on an exploded view, and displaying an exploded view on said display according to said determined components spacing.

[Claim 8] It is the exploded view listing device characterized by determining the value which subtracted [which subtracted, and set to claim 7 and added said components spacing decision means to the difference of said minimum value of an inner product value and maximum which were calculated] the predetermined gap value as spacing between said each part articles.

[Claim 9] In what has the operation part which displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components which constitute an assembly based on said configuration data The erector the erector who consists [the assembly sequence of said component and] of assembly remembers data to be Data memory, A means to generate the 2nd polyhedron which includes the configuration of the 1st polyhedron which attaches from the configuration data of the components in said configuration data memory, and includes the configuration of components, and attached components, The configuration data and said erector of said 1st and 2nd generated polyhedrons are based on the direction vector of assembly in data memory. The exploded view listing device characterized by establishing a means to determine spacing between said each part articles at the time of changing into a decomposition condition the components which constitute said assembly on an exploded view, and displaying an exploded view on said display according to said determined components spacing.

[Claim 10] In what has the operation part which displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components which constitute an assembly based on said configuration data The erector the erector who consists [the assembly sequence of said component and] of assembly remembers data to be Data memory, A contact surface detection means to search for the contact surface of attachment components and attached components based on the configuration data of the attachment components in said configuration data memory, and the configuration data of attached components, An inner product minimum value count means by which the top-most-vertices coordinate and said erector of the contact surface searched for calculate an inner product with the direction vector of assembly in data memory, and calculate the minimum value of the inner product value, An inner product maximum count means to calculate the inner product of the top-most-vertices coordinate of said attachment component, and said direction vector of assembly, and to calculate the maximum of the inner product value, Ask for the difference of said minimum value of an inner product value and maximum which were calculated, and it is based on the difference for which it asked. The exploded view listing device characterized by establishing a means to determine spacing between said each part articles at the time of changing into a decomposition condition the components which constitute said assembly on an exploded view, and displaying an exploded view on said display according to said determined components spacing.

[Claim 11] In the approach which has the operation part which displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components which constitute an assembly based on said configuration data, and creates the exploded view of said assembly Read the top-most-vertices coordinate of components from said configuration data memory, and the erector the erector who consists [the assembly sequence of components and] of assembly remembers data to be reads the direction vector of assembly from data memory. While calculating the inner product of this top-most-vertices coordinate of components and direction vector of assembly that were read and calculating the minimum value of that inner product value The inner product of said top-most-vertices coordinate of

components and direction vector of assembly which were read is calculated. The exploded view creation approach which calculates the maximum of that inner product value and is characterized by determining spacing between said each part articles at the time of changing into a decomposition condition the components which constitute said assembly based on the difference for which it asked on an exploded view, and displaying an exploded view on said display according to this determined components spacing.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the equipment and the approach of creating an exploded view by which it is created in case the assembly procedure in the structure and the production process of an assembly which consist of two or more components, and the procedure of maintenance check or repair are shown.
[0002]
[Description of the Prior Art] An exploded view is a drawing which took each components into pieces from the condition of having combined components, and has been arranged in order of assembly in the direction contrary to a direction with a group. Such an exploded view is used when the assembly procedure in the configuration and production process of an assembly which consist of two or more components, maintenance check, the procedure of repair, etc. are shown. Conventionally, the exploded view was created in handwriting based on the assembly procedure which showed a working drawing, assembly procedures, etc., such as assembly drawing of a product, and part drawing. Moreover, in recent years, when a user moves components with a migration command in consideration of an assembly procedure based on the data which the CAD system was used for the product design, created the assembly model of the product created using the 3-dimensional CAD system, and created by this 3-dimensional CAD system, the exploded view is created.
[0003]
[Problem(s) to be Solved by the Invention] With the above-mentioned conventional technique, since the exploded view was created with the help, it took time amount very much. Moreover, when using the configuration data of the assembly created by the 3-dimensional CAD system, the configuration of components did not need to be written at least, but in order for an operator to direct the migration direction and movement magnitude and to move components one by one, it took time and effort. Moreover, in a manufacture preparation phase, in the phase where the assembly procedure is examined, an assembly procedure needs to look at whether it is the right, and needs to check a configuration. However, with trial-and-error, whenever it changes a procedure, in order to remake an exploded view for the decision of an assembly procedure with a help, there was a problem that a man day started very much in it.
[0004] The purpose of this invention is to offer the equipment and the approach of creating easily the exploded view which can check an assembly procedure easily.
[0005]
[Means for Solving the Problem] In what has the operation part by which this invention displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components with which an assembly is constituted based on said configuration data A means by which an erector determines the arrangement location of the decomposition condition of the components which constitute said assembly based on data and said configuration data is established, and the description is shown in having displayed the exploded view on said display according to this determined arrangement location.
[0006] Data specifically consist [the assembly sequence of components, and] of assembly like said erector.

Said arrangement positioning means The inner product of the top-most-vertices coordinate of the components in configuration data memory and the direction vector of assembly is calculated. While calculating the minimum value of the inner product value, the inner product of said top-most-vertices coordinate of components and direction vector of assembly which were read is calculated. The maximum of that inner product value is calculated, spacing between each part articles at the time of changing into a decomposition condition the components which constitute said assembly based on the difference for which it asked on an exploded view is determined, and an exploded view is displayed on said display according to this determined components spacing.

[0007]

[Function] According to this invention, the inner product of the top-most-vertices coordinate of the components in configuration data memory and the direction vector of assembly calculates by the arrangement positioning means. While the minimum value of the inner product value is calculated, the inner product of said top-most-vertices coordinate of components and direction vector of assembly which were read calculates. Spacing between each part articles at the time of changing the components with which the maximum of the inner product value is calculated, and constitutes said assembly based on the called-for difference into a decomposition condition on an exploded view is determined. Since an exploded view is displayed on a display according to this determined components spacing Automatic creation of an exploded view is attained, the activity currently done conventionally that an operator directs the migration direction and movement magnitude and moves components one by one becomes unnecessary, and it becomes possible to reduce the man day of exploded view creation.

[0008]

[Example] One example of the configuration of the exploded view listing device by this invention is shown in drawing 1 . An input device 101 consists of equipment which receives data from alien machines, such as the device and communication device which incorporate the directions from users, such as a keyboard and a mouse, and a floppy disk drive unit. An arithmetic unit 102 is constituted from a CPU, the data in a store 103 are calculated by the program memorized by the store 103, or data with an input device 101 and an output unit 104 are exchanged. A store 103 is constituted from RAM, a magnetic disk, etc., and memorizes a program and data. An output unit 104 consists of devices which deliver data to alien machines, such as indicating equipments, such as CRT, a communication device, and a floppy disk drive unit.

[0009] The configuration data 105, the assembly procedure data 106, the configuration data input program 107, the assembly procedure input program 108, the components migration program 109 with a group, and the exploded view display program 110 are stored in a store 103. The configuration data 105 memorize the geometric information on an assembly. The assembly procedure data 106 memorize the components 111 with a group, and the direction 112 with a group for every sequence of assembly. The configuration data input program 107 incorporates the geometric information on an assembly from an input device 101, and stores it in the configuration data 105. An assembly procedure input program incorporates components with a group, and a direction with a group for every sequence of assembly from an input device 101, and stores them in the assembly procedure data 106. In a certain assembly procedure step, from the configuration data of the components 111 with a group, the configuration data of components [finishing / attachment / already], and the direction 112 with a group, the components migration program 109 with a group calculates the components location with a group on an exploded view, and changes the components location of the components with a group in the configuration data 105. The exploded view display program 110 outputs the configuration data 105 to an output unit 104.

[0010] A user inputs the input of the configuration data 105 and the assembly procedure data 106 using a mouse and a keyboard, or it inputs the data which created data through a network, a floppy disk, etc. by the alien machine.

[0011] An example of the exploded view creation approach in this example is shown in drawing 43 . In processing 4301, the arrangement location of the components in the configuration data and the assembly completion condition of components which are set as the object of assembly is incorporated. In processing 4302, the assembly procedure data which consist of an assembly sequence of components and data of the

direction of assembly are incorporated. In processing 4303, the arrangement location in the condition of the part shape, the arrangement location, the assembly sequence, and having decomposed from assembly about each components which constitute an assembly is calculated. In processing 4304, a part shape is displayed based on the arrangement location for which it asked by processing 4303.

[0012] The detailed configuration of one example of the components migration program 109 with a group is shown in drawing 2 . The procedure sequential readout program 201 reads the assembly procedure step of each in the assembly procedure data 106, and stores it in the components memory 202 with a group, and the direction memory 208 with a group. The direction 112 with a group expresses the direction of [when attaching components with a group to components / finishing / assembly / already], and expresses it with a unit vector. It is Va about this. It carries out. Moreover, the finishing components memory 204 with a group stores the list of components attached by the procedure step before a certain assembly procedure step. The inner product minimum value count program 205 is attached from the finishing components memory 204 with a group, reads the list of ending components, calculates the top-most vertices of those components, and the inner product of the installation direction, and calculates the minimum value in it. It is Dmin about this. It carries out. The inner product maximum count program 206 reads the components attached from the components memory 202 with a group, and takes out the coordinate value of the top-most vertices of those components from the configuration data 105. The inner product of those coordinate values and a direction with a group is calculated, respectively, and the maximum in it is calculated. It is Dmax about this. It carries out. The components repositioning program 207 with a group asks for movement vector V of components with a group by the following formulas (1). However, Dconst It is the clearance between the constant rates defined beforehand.

[0013]

[Equation 1]

V=(Dmin-Dmax-Dconst) *Va -- (1)

And it is the location Mo of components with a group from configuration data. It takes out and writes in configuration data by making into a new components location the value M to which the migration matrix Mv searched for from movement vector V was applied. This count is based on the following formulas (2).

[0014]

[Equation 2]

M=Mv*Mo -- (2)

The finishing components addition program 208 with a group adds the components with a group which changed the location to the finishing components memory 204 with a group.

[0015] Next, the principle in which the components migration program 109 with a group creates an exploded view using a concrete example is explained.

[0016] Drawing 3 shows the condition that two components 301 and 302 were assembled. Components 301 consider as finishing components with a group, and components 302 consider as components with a group. The vector 303 shows the direction with a group of components 302. In the inner product minimum value count program 205, the coordinate value of the top-most vertices of the finishing components 301 with a group and the minimum value of the inner product of the direction 303 with a group are calculated. In the example of drawing 3 , an inner product with top-most vertices 401 becomes min, and the value is set to 402 as shown in drawing 4 . That is, when the configuration of the finishing components 301 with a group considers the direction 303 with a group as the number line, it will exist in a larger field than the minimum value 402 of an inner product. On the other hand, in the inner product maximum count program 206, the maximum of the inner product of the coordinate value of the top-most vertices of the components 302 with a group and the direction 303 with a group is calculated. In the example of drawing 3 , the inner product of top-most vertices 403 and a direction with a group serves as max, and the value is set to 404 as shown in drawing 4 . That is, when the configuration of the components 302 with a group considers the direction 303 with a group as the number line, it will exist in a field smaller than the maximum 404 of an inner product. If maximum 404 is lengthened from the minimum value 402, the value will become like 405, and when only the part of 405 moves components with a group in the direction with a group, each existence region on the number line of the

direction 303 with a group of the finishing components 301 with a group and the components 302 with a group stops therefore, lapping. However, since the field has touched the way things stand, movement magnitude will be set to 502 if the constant rate 501 beforehand defined from the value of 405 is subtracted like drawing 5 . If only movement magnitude 502 carries out the parallel displacement of the components 302 with a group to the direction 303 with a group, the exploded view with which the finishing section 301 with a group and the components 302 with a group were separated will be obtained.

[0017] The processing flow of a components migration program with a group is shown in drawing 6 . Let the components with a group of the 1st procedure step in assembly procedure data be finishing components with a group in processing 601. In processing 602, processing 603 - processing 607 are applied one by one about the last procedure step from the 2nd procedure step. In processing 603, the current components with a group and the current direction with a group of a procedure step are read from procedure data with a group. In processing 604, all the top-most-vertices coordinates of components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a group are calculated, and the maximum in the value is calculated. In processing 605, all the top-most-vertices coordinates of finishing components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a group are calculated, and the minimum value in the value is calculated. In processing 606, the location of components with a group is moved by the vector obtained applying a direction with a group to the value which lengthened maximum from the minimum value and subtracted the constant rate further. In processing 607, the components with a group which moved and changed into the decomposition condition are added to finishing components with a group.

[0018] Next, signs that an exploded view is created by the processing flow of drawing 6 are explained using a concrete example. Drawing 7 R> 7 shows the configuration of the assembly used for explanation. Components 702 are fixed to a plate 701 with a bolt 703, and, as for the structure of an assembly, components 704 are being fixed to the plate 701 with the bolt 705. The direction with a group of the direction vector 706, components 704, and a bolt 705 of the direction with a group of components 702 and a bolt 703 is the direction vector 707.

[0019] The assembly procedure data of the assembly of drawing 7 become like drawing 8 . A procedure step 801 is the sequence number of an assembly procedure, and performs assembly to this numerical order. The components 802 with a group express the components attached in a certain procedure step. The components shown in drawing 8 correspond to the sign attached to the components of drawing 7 . The direction 803 with a group is a direction vector showing the direction with a group of the components in a certain procedure step. The direction with a group shown in drawing 8 R> 8 corresponds to the sign attached to the direction vector with a group of drawing 7 . In addition, since the 1st procedure step 804 is the case where components are placed first, it does not need to specify a direction with a group.

[0020] First, let the components 701 with a group of the 1st procedure step 804 be assembly finishing components by processing 601. In this phase, it is still the assembly condition of drawing 7 . In addition, on explanation, in order to distinguish components with a group, and finishing components with a group, shading shows finishing components with a group and hatching of a slash shows components with a group. In the state of drawing 7 , components 701 are finishing components with a group. Next, processings 603-607 are repeated and applied by procedure steps 2-5 by processing 602. If processing 603 is performed to the 2nd procedure step 805, the components with a group will be set to 702. This condition is shown in drawing 9 . If processing 604 is performed and the maximum 901 of an inner product will perform processing 605, the minimum value 902 of an inner product will be obtained, if processing 606 is performed, the difference of the minimum value and maximum will be set to 903, if the clearance between constant rates is set to 904, a movement vector 905 will be obtained, and the location of the components 702 after migration is set to 906. If processing 607 is performed, the components 702 which were components with a group will turn into finishing components with a group in the location of 906. A situation while performing processing 603 - processing 607 to the 3rd procedure step 806 is shown in drawing 10 . The components with a group are bolts 703 and the direction vector with a group is 706. Since the components with a group are bolts 703 when processing 604 is performed, the maximum of an inner product is set to 1001. Since the finishing components with a group are

components 701 and components 702 when processing 605 is performed, the minimum value of an inner product is set to 1002. The value 1003 which subtracted 1001 from 1002 is acquired, and it will become the location of 1006 if 703 which is components with a group is moved to the direction 706 with a group with the value 1005 which lengthened constant value 1004 from now on. And components 703 turn into finishing components with a group in the location of 1006. A situation while performing processing 603 - processing 607 to the 4th procedure step 807 is similarly shown in drawing 11 . In this case, the maximum and the minimum value of an inner product are equal, and become like 1101 of drawing 11 . Therefore, movement magnitude is set to 1102 for a clearance. Therefore, the location of the components 704 after migration is set to 1103. Furthermore, a situation while performing processing 603 - processing 607 to the 5th procedure step 808 is shown in drawing 12 . Movement magnitude will be set to 1205 if, as for the difference of 1202, the minimum value, and maximum, the minimum value of the top-most vertices of 1201 and the finishing components 701-704 with a group and the inner product of the direction 707 with a group sets 1203 and a clearance to 1204 in the maximum of the top-most vertices of the components 705 with a group, and the inner product of the direction 707 with a group. Therefore, the location of the components 705 after migration is set to 1206. The appearance of the configuration data after processing termination is shown in drawing 13 . An exploded view is obtained by displaying this.

[0021] Although two dimensions explained at this example, this is realizable as it is also by three dimensions with this invention. For example, in drawing 14 , 1402 and a direction with a group are set [components with a group] to 1403 of the direction of facing down for 1401 and finishing components with a group. The maximum of the inner product of the direction 1403 with a group and the top-most-vertices coordinate of the components 1401 with a group is set to 1404. Moreover, the minimum value of the inner product of the direction 1403 with a group and the top-most-vertices coordinate of the finishing components 1402 with a group is set to 1405. The thing 1407 which lengthened maximum 1405 from the minimum value 1404, and lengthened a part for a clearance 1406 further serves as a movement vector of components with a group. Configuration data after moving the components 1402 with a group to drawing 15 by the movement vector are shown.

[0022] Moreover, in the above-mentioned example, although the inner product of the top-most vertices of components with a group and components with a group-ed and a direction vector with a group was calculated, if the control point of a curve and a curved surface is also made into the object of inner product count when a curved surface is included in components, the more intelligible exploded view of the components which touch on a curved surface can be created. In drawing 16 , 1601 and components with a group-ed are set to 1602 for components with a group. When the curved surface 1603 is included in components with a group, and components with a group-ed, also let the control points 1605 and 1606 of a curved surface 1603 be the objects of count with the coordinate of top-most vertices 1607 and 1608 in the inner product ******** case with the direction vector 1609 with a group. Consequently, the coordinate value of the top-most vertices and the control point of the components 1601 with a group and the maximum of an inner product with the direction vector 1609 with a group turn into a coordinate value of top-most vertices 1608, and the inner product value 1610 of the direction vector 1609. Moreover, the coordinate value of the top-most vertices and the control point of the components 1602 with a group-ed and the minimum value of an inner product with the direction vector 1609 with a group turn into a coordinate value of a control point 1605, and the inner product value 1611 of the direction vector 1609. The value 1613 which subtracted the amount 1612 of clearances serves as movement magnitude of the components 1601 with a group from the difference of the minimum value 1611 and maximum 1610. The configuration data after moving to drawing 17 are shown. Thus, although all components including a curve or a curved surface are inseparable only with a top-most-vertices coordinate, the exploded view which separated all the components can be created by using the control point of a curve or a curved surface.

[0023] In other examples of this invention, the top-most vertices of the bounding box which is the polygon which includes a part shape are used instead of the top-most vertices of the configuration data of components, or a control point. The configuration of the components movement magnitude count program 109 with a group which realizes this example to drawing 18 R> 8 is shown. This program adds the bounding box

count program 1801 to the components movement magnitude count program 109 with a group shown in drawing 2 . The bounding box count program 1801 asks for the polygon which includes a part shape with reference to the configuration data 105. The inner product minimum value count program 205 reads the bounding box corresponding to the components memorized by the finishing components memory 204 with a group from the bounding box count program 1801, calculates an inner product with the direction vector with a group memorized one by one by a top-most-vertices coordinate and the direction memory 208 with a group, and calculates the minimum value out of them. The inner product maximum count program 206 reads the bounding box corresponding to the components memorized by the finishing components memory 204 with a group from the bounding box count program 1801, calculates an inner product with the direction vector with a group memorized by each top-most-vertices coordinate and the direction memory 208 with a group, and calculates maximum out of them. The part of others of drawing 18 is the same as that of drawing 2 .

[0024] The bounding box which is the polygon which includes a part shape is the cube 1902 parallel to the axis of coordinates 1901 of components system of coordinates as shown in drawing 19 , or assembly system of coordinates. Such a bounding box is calculable by calculating the maximum of the direction of a x axis of the coordinate value of top-most vertices or a control point, the minimum value and the maximum of the direction of the y-axis, the minimum value and the maximum of the direction of the z-axis, and the minimum value which constitute a part shape, respectively. Before count of a bounding box calculates movement magnitude, it may follow the bounding box of all components beforehand, or may be set, and it may be performed during movement magnitude count. Moreover, you may include in the configuration data 105. At this time, the bounding box count program 1801 becomes unnecessary. The exploded view which separated all the components since it became surely larger than the movement magnitude which calculated the movement magnitude of components with a group using the coordinate of top-most vertices or a control point since the bounding box includes the part shape completely can be created.

[0025] In addition, here explains this example using a bounding box concretely below. Drawing 44 is a flow chart which shows the procedure of opting for the components arrangement on an exploded view. In processing 4401, the arrangement location of the components in the configuration data and the assembly completion condition of components which are set as the object of assembly is incorporated. In processing 4402, the assembly procedure data which consist of an assembly sequence of components and data of the direction of assembly are incorporated. In processing 4403, after emptying the part list with a group-ed which is a list of components [finishing with a group], the 1st component with a group of assembly procedure data is set to a part list with a group-ed. In processing 4404, processing 4405 - processing 4409 are repeated in order of an assembly sequence about the last components with a group from the 2nd components with a group of assembly procedure data. The bounding box of components with a group is computed in processing 4405. Next, in processing 4406, the bounding box which includes all the components contained in a part list with a group-ed is computed. In processing 4407, the movement magnitude of components with a group with which each other bounding box adjoins is calculated from the bounding box of a direction with a group, and components with a group, and the bounding box of components with a group-ed. In processing 4408, only the movement magnitude calculated by processing 4407 moves components with a group to a direction with a group, and an opposite direction. In processing 4409, the components name with a group which migration finished is added to a part list with a group-ed.

[0026] The detailed flow chart of processing 4407 is shown in drawing 45 . In processing 4501, each top-most vertices of the bounding box of components with a group are made into the starting point, and the half-line prolonged in the opposite direction of a direction with a group is drawn. In the case of two dimensions, four half-lines can be drawn. In the case of three dimensions, six half-lines can be drawn. It asks for the intersection of the half-line and the bounding box of components with a group-ed which were created by processing 4501 in processing 4502. When one half-line has the bounding box of components with a group-ed, and two intersections, let the more distant one from the starting point be an intersection. In processing 4503, the distance from the starting point to an intersection is computed about each half-line. Distance is set to 0 when there is no intersection. In processing 4504, maximum is chosen among the distance found by processing 4503, and let it be movement magnitude.

[0027] The example of activation of the exploded view creation by this example is shown in drawing 46 - drawing 48 . Drawing 46 is the drawing of the completion condition of the assembly for explanation. It has the structure where the bolt 4602 is being fixed to the plate 4601. A bolt 4602 presupposes that components with a group and a plate 4601 is [the direction with a group of a bolt 4602] 4603 with components with a group-ed. Processing is explained illustrating information used for drawing 47 R> 7 in the middle of count, such as a bounding box and a half-line. The bounding box 4701 of components with a group-ed and the bounding box 4702 of components with a group are first computed by processing 4405 and processing 4406. Next, processing 4501 draws out half-lines 4707, 4708, 4709, and 4710 to the direction 4603 with a group, and an opposite direction from the top-most vertices 4703, 4704, 4705, and 4706 of the bounding box 4702 of components with a group. Next, the intersections 4711, 4712, 4713, and 4714 of the bounding box 4701 of half-lines 4707, 4708, 4709, and 4710 and components with a group-ed are computed by processing 4502. Next, the distance between the starting point and an intersection, i.e., top-most vertices 4703 - an intersection 4711, top-most vertices 4704 - an intersection 4712, top-most vertices 4705 - an intersection 4713, top-most vertices 4706 - an intersection 4714 are computed by processing 4503. Furthermore, in the case of maximum, therefore drawing 47 , let distance of top-most vertices 4703 - an intersection 4711 be movement magnitude among the distance between the starting point and an intersection by processing 4504. Drawing 48 shows the condition of having moved the components 4602 with a group to the direction 4603 with a group, and the opposite direction with the movement magnitude 4801 computed by processing 4408. Thus, if the movement magnitude calculated by the processing flow shown in drawing 45 is used, components with a group can be arranged in the location with which the bounding box of components with a group and components with a group-ed does not lap, therefore components with a group and components with a group-ed can be separated, and components can be arranged. If this is applied in order of the assembly procedure, the exploded view of the whole assembly can be created automatically.

[0028] The example of further others of this invention is shown below. In the exploded view listing device of drawing 1 , drawing 2020 is a functional block diagram changed into the exploded view display program 2003 which displayed the exploded view display program 110 on the components migration program 2002 with a group which took the direction of a look into consideration for the components migration program 109 with a group in the direction of a look into which it was inputted by the direction input program 2001 of a look while adding the direction input program 2001 of a look. The direction input program 2001 of a look incorporates directions and other programs of a user, and the look vector from a calculating machine from an input device 101. From the direction input program 2001 of a look, the components migration program 2002 with a group in consideration of the direction of a look changes the location of the components which determined the movement magnitude of components from reception, and the configuration data 105, the assembly procedure data 106 and the direction vector of a look of an assembly, and read the direction vector of a look from the configuration data 105, and writes it in configuration data.

[0029] The block diagram of one example of the components migration program 2002 with a group which took the direction of a look into consideration to drawing 21 is shown. The procedure sequential readout program 201 reads the assembly procedure step of each in the assembly procedure data 106, and stores it in the components memory 202 with a group, and the direction memory 208 with a group. The direction 112 with a group expresses the direction of [when attaching components with a group to components / finishing / assembly / already], and expresses it with a unit vector. It is Va about this. It carries out. Moreover, the finishing components memory 204 with a group stores the list of components attached by the procedure step before a certain assembly procedure step. The projection program 2101 to the flat surface which makes the direction of a look a normal is the direction vector Ve of a look from the direction input program 2001 of a look. The direction vector Va with a group is read from reception and the direction memory 208 with a group, and it is the direction Ve of a look by the following formulas (3). Direction vector Va with a group to the flat surface made into a normal vector Projection vector **** It calculates.

[0030]

[Equation 3]

****=(VexVa)/|VexVa|xVe -- (3)

It attaches from the finishing components memory 204 with a group, the list of ending components is read, and the inner product minimum value count program 2102 is the top-most vertices of those components, and the projection vector ****. An inner product is calculated and the minimum value in it is calculated. It is Dmin about this. It carries out. The inner product maximum count program 2103 reads the components attached from the components memory 202 with a group, and takes out the coordinate value of the top-most vertices of those components from the configuration data 105. Those points and projection vectors **** An inner product is calculated and the maximum in it is calculated. It is Dmax about this. It carries out. The components repositioning program 2104 with a group asks for movement vector V of components with a group by the following formulas (4). However, Dconst It is the clearance between the constant rates defined beforehand.
[0031]
[Equation 4]
V=(Dmin-Dmax-Dconst) *Va/(****-Va) -- (4)
And it is the location Mo of components with a group from the configuration data 105. Migration matrix Mv which was taken out and searched for from movement vector V This count written in the configuration data 105 by making the applied value M into a new components location is based on the following formulas (2).
[0032]
[Equation 5]
M=Mv*Mo -- (2)
The finishing components addition program 208 with a group adds the components with a group which changed the location to the finishing components memory 204 with a group.
[0033] Next, the principle in which the components migration program 2002 with a group creates an exploded view using a concrete example is explained. Drawing 22 shows the condition that two components 2201 and 2202 were assembled. Components 2201 consider as finishing components with a group, and components 2202 consider as components with a group. A vector 2203 is the direction Va with a group of components 2202. It is shown. The direction vector Ve of a look In drawing 22 , it considers as the direction of [from this side] the other side at right angles to space. Drawing 23 is the direction vector Ve of a look. Direction vector Va with a group It is drawing which looked at the assembly of drawing 22 from the perpendicular direction. a vector 2301 -- the direction vector Ve of a look it is . Direction vector Vt perpendicular to the space of drawing 23 The direction vector Ve of a look A perpendicular and direction vector Va with a group Since it is perpendicular, it is the direction vector Ve of a look. Direction vector Va with a group It is the vector which normalized the vector calculated by the outer product. Therefore, Vt It asks by the following formulas (5).
[0034]
[Equation 6]
Vt=(VexVa)/|VexVa| -- (5)
However, Vt It considers as the vector 2302 which goes to the other side from this side in drawing 23 .
[0035] The direction Ve of a look Direction vector Va with a group to the flat surface made into a normal vector Projection vector **** In drawing 23 , it becomes the direction vector 2303. Projection vector **** Vt A perpendicular and the direction Ve of a look Since it is perpendicular, it is Vt. Ve It is the vector calculated by the outer product. However, Vt Ve Since it intersects perpendicularly, it is not necessary to normalize. If the above is summarized, it is the projection vector ****. It asks by the following formulas (6).
[0036]
[Equation 7]
****=VtxVe=(VexVa)/|VexVa|xVe -- (6)
In the inner product minimum value count program 2102, the coordinate value of the top-most vertices of the attached components 2201 and the minimum value of the inner product of the projection vector 2303 are calculated. In the example of drawing 22 , an inner product with top-most vertices 2304 becomes min, and the value is set to 2305 as shown in drawing 23 . On the other hand, in the inner product maximum count program 2103, the maximum of the inner product of the coordinate value of the top-most vertices of the components 2202 with a group and the projection vector 2303 is calculated. In the example of drawing 22 , the inner product of top-most vertices 2306 and the projection vector 2303 serves as max, and the value is set to 2307

as shown in drawing 23 . Next, if maximum 2307 is lengthened from the minimum value 2305, the value will become like 2308. It will be set to 2310 if the constant rate 2309 beforehand defined from the value of 2308 is subtracted. Since 2310 is the movement magnitude on a projection vector, it needs to calculate movement magnitude from which the result projected on the projection vector 2303 in the direction 2203 with a group is set to 2310. This should just break the movement magnitude 2310 of projection vector 2303 direction by the inner product of the projection vector 2303 and the ****** vector 2203. Thus, movement magnitude 2311 is calculable. If only movement magnitude 2311 carries out the parallel displacement of the components 2202 with a group in the direction 2203 with a group, it will become like drawing 24 , and if it sees from a look, as drawing 25 shows, an exploded view without the lap parts of the finishing section 2201 with a group and the components 2202 with a group will be obtained.

[0037] The processing flow of the components migration program with a group which took the direction of a look into consideration to drawing 26 is shown. In processing 2601, the direction vector of a look is incorporated from the direction input program of a look. Let the components with a group of the 1st procedure step in assembly procedure data be finishing components with a group in processing 2602. In processing 2603, processing 2604 - processing 2610 are applied one by one about the last procedure step from the 2nd procedure step. In processing 2604, the current components with a group and the current direction with a group of a procedure step are read from procedure data with a group. In processing 2605, when [parallel] confirming whether the direction of a look and a direction with a group are parallel, since an outer product is set to 0, it considers as an error. By processing 2606, it is the direction **** with a projection group. It calculates by the above-mentioned formula (6). In processing 2607, all the top-most-vertices coordinates of components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a projection group are calculated, and the maximum in the value is calculated. In processing 2608, all the top-most-vertices coordinates of finishing components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a projection group are calculated, and the minimum value in the value is calculated. In processing 2609, the location of components with a group is moved by the vector obtained applying a direction with a group to the value which broke the value which lengthened maximum from the minimum value and subtracted the constant rate further by the inner product of a direction with a group, and a direction with a projection group. If a movement vector is set to V, it will ask by the following formulas (4).

[0038]

[Equation 8]

V=(Dmin-Dmax-Dconst)/(****-Va)*Va -- (4)

However, the minimum value of the inner product which calculated Dmin by processing 2608, and Dmax are the maximum of the inner product for which it asked by processing 2607, and Dconst. The clearance value of a constant rate, and Va A direction vector with a group, and **** The direction vector with a projection group and Va which were calculated by processing 2606 It is the direction vector with a group read by processing 2604. In processing 2610, the components with a group which moved and changed into the decomposition condition are added to finishing components with a group.

[0039] In this example, although the coordinate value of top-most vertices was used for inner product count with a projection vector, when it includes a curved surface, the coordinate value of the control point of a curved surface may also be used with a top-most-vertices coordinate value. Moreover, the top-most-vertices coordinate of the bounding box which is the polyhedron which includes the configuration of components may be used instead of top-most vertices or a control point.

[0040] The detailed configuration 2701 of the example of further others of the components migration program 109 with a group in drawing 1 and drawing 2 is shown in drawing 27 . The procedure sequential readout program 201 reads the assembly procedure step of each in the assembly procedure data 106, and stores it in the components memory 202 with a group, and the direction memory 208 with a group. The direction 112 with a group expresses the direction of [when attaching components with a group to components / finishing / assembly / already], and expresses it with a unit vector. It is Va about this. It carries out. Moreover, the finishing components memory 204 with a group stores the list of components attached by the procedure step

before a certain assembly procedure step. The contact surface detection program 2702 reads components with a group from the components memory 202 with a group, reads finishing components with a group from the finishing components memory 204 with a group, and detects the contact surface between components with a group, and finishing components with a group with reference to the configuration data 105.
[0041] The inner product minimum value count program 205 takes out the contact surface of components with a group, and finishing components with a group from the contact surface detection program 2702, calculates the inner product of the top-most vertices and installation direction, and calculates the minimum value in it. It is Dmin about this. It carries out. The inner product maximum count program 206 reads the components attached from the components memory 202 with a group, and takes out the coordinate value of the top-most vertices of those components from the configuration data 105. The inner product of those points and a direction with a group is calculated, and the maximum in it is calculated. It is Dmax about this. It carries out. The components repositioning program 207 with a group asks for movement vector V of components with a group by the above-mentioned formula (1). And it is the location Mo of components with a group from configuration data. Migration matrix Mv which was taken out and searched for from movement vector V It writes in configuration data by making the applied value M into a new components location. This count is based on the above-mentioned formula (2). The finishing components addition program 208 with a group adds the components with a group which changed the location to the finishing components memory 204 with a group.
[0042] Next, the principle in which the components migration program 109 with a group creates an exploded view using a concrete example is explained. Drawing 28 shows the condition that two components 2801 and 2802 were assembled. Components 2801 consider as finishing components with a group, and components 2802 consider as components with a group. The vector 2803 shows the direction with a group of components 2802. First, the contact surface detection program 2702 detects the contact surface between the finishing components 2801 with a group, and the components 2802 with a group, and as shown in drawing 29 , it acquires the bearing surface 2901 and die face 2902 of ****. In the inner product minimum value count program 205, the minimum value of the inner product of the coordinate value of the top-most vertices of a field 2901 and a field 2902 and the direction 2803 with a group is calculated. In the example of drawing 29 , the top-most vertices 3001 of a field 2901 and the inner product of the direction vector 2803 become min, and the value is set to 3002 as shown in drawing 30 . On the other hand, in the inner product maximum count program 206, the inner product of the coordinate value of the top-most vertices of the components 2802 with a group and the direction 2803 with a group is calculated. In the example of drawing 28 , the inner product of top-most vertices 3003 and the direction 2803 with a group serves as max, and the value is set to 3004 as shown in drawing 30 . Next, maximum 3004 is lengthened from the minimum value 3002, and movement magnitude will be set to 3006 if the constant rate 3005 defined further beforehand is subtracted. If only movement magnitude 3006 carries out the parallel displacement of the components 2802 with a group to the direction 2803 with a group, the exploded view with which the finishing section 2801 with a group like drawing 31 and the components 2802 with a group were separated will be obtained.
[0043] In this example, although the top-most vertices of the contact surface were used for inner product count, a curved surface and a curved control point may also be used for inner product count with top-most vertices. Moreover, it asks for the bounding box which includes the contact surface beforehand instead of the top-most vertices of the contact surface, or a control point, and the top-most vertices of this bounding box may be used for inner product count with a direction vector with a group. Furthermore, a contact surface retrieval program may be included in the components migration program 2002 with a group in consideration of the direction of a look shown in drawing 21 , and the top-most vertices of the contact surface may be used for inner product minimum value count instead of the top-most vertices of components.
[0044] Next, the configuration of the example of further others by this invention is shown in drawing 32 . Drawing 32 adds the tie line creation program 3201 which creates the tie line with which correspondence of the contact surface of components with a group and the contact surface of finishing components with a group is expressed to the components migration program 2701 with a group equipped with the contact surface detection program of drawing 27 . Actuation of the tie line creation program 3201 is explained using drawing 33 and drawing 34 . The tie line creation program 3201 calculates reception, for example, the center of gravity, for

the contact surface from the contact surface detection program 2702. In the example of drawing 33 , the contact surface 2901 is passed from the contact surface detection program 2702, and a center of gravity 3301 is searched for. Moreover, the point 3302 that only the movement vector 3006 moved the movement vector 3006 of components with a group from the components repositioning program 207 with a group in the center of gravity 3301 of reception and the contact surface is searched for. And the segment which connects between a point 3301 and points 3302 is added to the configuration data 105. ** [a display of this / display / like drawing 34 / with an exploded view / the tie line 3401 showing correspondence of the contact surface of components with a group and the contact surface of finishing components with a group] Although the alternate long and short dash line expressed the tie line 3401 by drawing 34 , it may be displayed by the size of a different color from the line showing a configuration, or a line.

[0045] In case the movement vector of components with a group is calculated in the example described so far, it is the clearance Dconst between constant value. Although used, this clearance may be calculated from the direction vector of a look, and a direction vector with a group.

[0046] Drawing 35 shows the example in the case where the clearance between components with a group and finishing components with a group is constant value, and the case of calculating from the direction vector of a look, and a direction vector with a group. Let the direction of a look be a vector 3501. A clearance will be set to 3505 supposing it attaches components 3502 and components 3503 in the direction 3504 with a group. In this case, since the direction 3504 with a group is perpendicular to the direction 3501 of a look, the clearance 3507 on the appearance seen from [3501] the look becomes equal to the actual clearance 3505. However, although a clearance is set to 3511 and it is the same magnitude as 3505 when attaching components 3508 and components 3509 in the direction 3510 of assembly, the apparent clearance 3512 seen from [3501] the look becomes small compared with 3507. If an apparent clearance becomes small, components will be able to approach and it will become unclear as an exploded view. An apparent clearance becomes so small that a direction with a group and the direction of a look approach in parallel. Then, for example, clearance Dconst It calculates like a degree type (7).

[0047]

[Equation 9]

$$D_{const}=\frac{C}{\sqrt{1-(V_a \cdot V_e)^2}} \qquad \cdots (7)$$

[0048] However, Va A direction vector with a group, and Ve The direction vector of a look and C are taken as a forward constant. For example, when attaching the components 3513 and components 3514 in drawing 35 R> 5 in the direction 3515 with a group, for the apparent die length 3517 of the vector 3516 of die length 1 parallel to the direction 3515 with a group, the die length of 3518 is Va. Ve Since it becomes the absolute value of an inner product, it becomes the denominator of the above-mentioned formula (7). Therefore, if a clearance 3519 is calculated by the above-mentioned formula (7), it is not based on the relation between the direction of assembly, and the direction of a look, but sees, and the upper clearance 3520 can be maintained at constant value C.

[0049] Next, depending on the structure of an assembly, it cannot attach one component at a time, but since it may not be assembled if it does not attach after assembling the subassembly which assembled some components, below, an example in case there is a subassembly is explained. First, the example of such an assembly is shown in drawing 49 . The assembly shown in drawing 49 consists of three components of components 4901, 4902, and 4903. In the case of such an assembly, it cannot assemble in order of components 4901, 4902, and 4903. After placing components 4901 first and assembling components 4902 and components 4903, it must attach to components 4901.

[0050] Such assembly procedure data of an assembly can be expressed like drawing 50 . Components level expresses the depth from the root 5101 when expressing the subassembly relation of an assembly with the tree structure, as shown in drawing 51 . Therefore, the level of the subassembly to which, as for 1 and the components level of components 4902 and 4903, the components level of components 4901 assembled 2 and components 4902 and 4903 is set to 1.

[0051] The flow chart of one example of the approach of creating an exploded view from assembly-sequence data which have a subassembly in the middle of the assembly by this invention is shown in drawing 52 . In processing 5201, the configuration data which consist of a components location in the configuration and assembly completion condition of components which constitute an assembly are inputted. In processing 5202, the assembly procedure data which consist of an assembly sequence and components with a group as shown by drawing 50 , the direction of assembly, and components level are inputted. In processing 5203, the 1st component with a group of assembly procedure data is set as a part list with a group-ed. In processing 5204, 5205 or less-processing processing is applied in order about the last components with a group from the 2nd components with a group of assembly procedure data. In processing 5205, components with a group judge whether they are the components of the beginning of a subassembly. For example, when it expresses a subassembly with components level like drawing 50 , and the components level of components with a group is larger than the components level of the components with a group in front of one, it becomes the components of the beginning of a subassembly, and by processing 5205, it is yes. It branches to the direction and processings 5206 and 5207 are performed. When components level is the same, when smaller than the level of front components with a group, it branches to the direction of no and processings 5208-5211 are performed. In processing 5206, the contents of the current part list with a group-ed are pushed to the stack for the components preservation with a group-ed. In processing 5207, after emptying a part list with a group-ed, current components with a group are set as a part list with a group-ed. By processing 5206 and processing 5207, the information on the components attached until now is saved temporarily, and the preparation which creates the exploded view about the assembly of a subassembly is completed. In processing 5208, the arrangement location of the components with a group in a decomposition condition is calculated from the direction with a group of the configuration data of components with a group, and components with a group-ed, and components with a group. The count approach is as the old example having described. In processing 5209, components with a group are arranged in the arrangement location calculated by processing 5208. In processing 5210, current components with a group judge whether they are the components of the last of subassembly assembly, and if it is the last components, it will branch to processing 5211. When current components with a group are not components of the last of subassembly components, it branches to the direction of no and branches to processing 5212. For example, when it expresses a subassembly with components level like drawing 50 , and the components level of the present components with a group is larger than the level of the components with a group after one, it becomes the components of the last of subassembly assembly. In processing 5211, the components group which carried out pop [of the components with a group-ed pushed at the end], and carried out pop to the stack for the components preservation with a group-ed is set as a current part list with a group-ed. In processing 5212, components with a group are added to a part list with a group-ed. After applying processing 5205 to all the components with a group of assembly procedure data by processing 5204, the configuration data after migration are displayed by processing 5213. Thereby, an exploded view is displayed.

[0052] The stack for the components preservation with a group-ed is realized in the table which consists of a column of a stack pointer 5301 and the components name 5303 as shown in drawing 5353 , and the components number 5302. A stack pointer 5301 saves the number of the part lists with a group-ed stored in the current stack. If a part list with a group-ed is newly pushed, only one stack pointer is added and the list of the number of components and components names is stored in the 3rd line 5304 in the line which made the value of the stack pointer after addition the index, and this case. On the contrary, when carrying out pop from a stack, while taking out the components name list of lines which made the value of a stack pointer 5301 the index, the line is deleted from a table and only one value of a stack pointer 5301 is subtracted. In the example of drawing 53 , since the value of a stack pointer 5301 is 2, the components name C is taken out from the second line 5305, this line 5305 is deleted, one value of a stack pointer 5301 is subtracted, and it is referred to as 1. Thus, the list of components names memorized later can be issued for the beginning.

[0053] The situation of the exploded view creation when applying processing of drawing 52 to the data of drawing 49 and the assembly procedure data of drawing 50 R> 0 is explained using drawing. Configuration data drawing 49 and assembly procedure data drawing 50 are inputted by processings 5201 and 5202. Next,

activation of processing 5203 sets the components 4901 with a group of the assembly procedure data of the beginning of drawing 50 as a part list with a group-ed. It confirms whether to be the components of the beginning of subassembly assembly by processing 5205 about the following components 4903 with a group. Although the level of the components 4901 with a group in front of one is 1, it turns out that the components level of the current components 4903 with a group is 2, and it is the beginning of subassembly assembly since the components level of current components with a group is larger. Then, 4901 is stored in the stack for components with a group-ed in the contents of the part list with a group-ed, and this case by processing 5206. And let the current components 4903 with a group be components with a group-ed by processing 5207. Then, a loop formation is carried out by processing 5204, and 5205 or less processing is applied to the components 4902 with a group. First, it confirms whether to be the beginning of a subassembly by processing 5205. Both the components level of the components 4903 with a group in front of one and the components level of the current components 4902 with a group are the same at 2. Therefore, since it is not the components of the beginning of subassembly assembly, it branches to no, and it progresses to processing 5208. Here, the arrangement location of a decomposition condition is calculated using the configuration data of the components 4902 with a group, and the components 4903 with a group-ed, and the direction data of assembly of the components 4902 with a group. The condition of having moved 4902 by processing 5209 based on the count result is shown in drawing 54 . Next, it investigates whether it is the last of subassembly assembly by processing 5210. The components level of components 4902 is 2, and since the components level of the following components 4902+4903 with a group is 1, they are the components of the last of subassembly assembly. Therefore, yes It branches to the direction, pop [of the components 4901] is carried out from a components stack with a group-ed, and it sets to a part list with a group-ed. Then, a loop formation is carried out by processing 5204, and 5205 or less processing is applied to the components 4902+4903 with a group. In the components 4902+4903 with a group, assembling and attaching two components 4902 and 4903 is shown. In processing 5205, the components level of components 4902+4903 is 1, and the components level of the components 4902 with a group in front of one is 2, and is not the components of the beginning of subassembly assembly. Therefore, it branches to no and progresses to processing 5208. Here, it asks for the location in the condition of having decomposed 4902 and 4903 by using components 4901 as components with a group-ed, having used as components with a group the location and configuration data of 4902 and 4903 of a decomposition condition which were calculated by the front loop formation, and 4902 and 4903 are moved by processing 5209. This condition is shown in drawing 55 . The exploded view of the assembly procedure data which have subassembly assembly as mentioned above can be created.

[0054] Although the example which expresses a subassembly with components level like drawing 50 as assembly procedure data with subassembly assembly was shown, the flag which shows the existence of subassembly assembly to assembly procedure data like drawing 56 is formed, and when a flag is 0, it is good also as those with subassembly assembly at subassembly assembly nothing and the time of 1. The assembly procedure of subassembly assembly prepares and expresses another assembly procedure data like drawing 57 . Correspondence with the components 4904 with a group with the subassembly assembly of drawing 56 and the assembly procedure data of subassembly assembly can take correspondence by investigating coincidence of a components name with a group and a subassembly name by memorizing the subassembly name to assembly procedure data. Such at the time of the expression of assembly procedure data, the judgment of being the beginning of subassembly assembly serves as the case where a subassembly flag is 1. Moreover, the assembly procedure data which are the same subassembly name as a components name with a group are searched, and let the first component with a group be new components with a group-ed. The judgment of being the last of subassembly assembly is judged by whether it reached to the last of the order data of assembly.

[0055] Next, the exploded view listing device shown in drawing 1 shows signs that the assembly procedure of an assembly is created, using a concrete example. Drawing 36 is the structure of the assembly used for explanation. The assembly consists of components 3601, components 3602, components 3603, and components 3604. An example of the assembly procedure which the user inputted into drawing 37 is shown. Components 3601 are placed first, then, components 3602 are attached from the upper part, and then this

attaches components 3603 from width, and, finally attaches components 3604 from the upper part. If an exploded view is created by the exploded view listing device according this to this invention, it will become like drawing 37 . For the user who looked at drawing 37 , it is a solution or ** that components 3601 become obstructive and are not attached although it is going to attach components 3603 from width. Since components 3603 are attached in components 3601 only from the upper part, a user gives directions to the assembly procedure input program 108, and changes the installation direction 3901 of components 3603 into installation from the upper part like the assembly procedure of drawing 39 . If an exploded view is created and the components migration program 109 with a group is displayed by the exploded view display program 110 by starting based on the assembly procedure of drawing 39 , it will become like drawing 40 . When drawing 4040 is seen, for a user, it is a solution or ** that components 3602 become obstructive and components 3603 are not attached since components 3603 are attached after attaching components 3602. Then, a user gives directions to the assembly procedure input program 108, and changes the procedure step 4101 with a group of components 3603 before the assembly procedure step 4102 of components 3602 like the assembly procedure of drawing 41 . If an exploded view is created and the components migration program 109 with a group is displayed by the exploded view display program 110 by starting based on the assembly procedure of drawing 41 , it will become like drawing 42 . When drawing 42 is seen, it is a solution or ** that there is no fault which components collide with in the middle of assembly. Thus, an assembly procedure is inputted and a right assembly procedure is obtained by repeating creating an exploded view.

[0056] In addition, here shows an example of the modification approach of the assembly procedure using the exploded view by this invention to drawing 58 further. The configuration data which consist of a components location in the configuration and assembly completion condition of components which constitute the assembly which creates an exploded view from processing 5801 are inputted. In processing 5802, an assembly sequence, components with a group, and the assembly procedure data that consist of assembly are inputted. In processing 5803, the components location of a decomposition condition is computed from builtup type-like data and assembly procedure data. In processing 5804, a part shape is displayed on the components location in the decomposition condition computed by processing 5803, and it displays as an exploded view. In processing 5805, it is asked to a user whether there is any modification of an assembly procedure. A user inputs the existence of the need for modification using input devices, such as a keyboard and a mouse. When there is no need for modification, procedure modification processing is ended. Processing 5806 is performed when modification is required. Directions of procedure modification are asked to a user in processing 5806. A user inputs components to be changed and the contents of modification using a keyboard or a mouse. The components for [two or more] modification are directed, and assembly procedure data are changed in processing 5807 based on the modification directions which the user inputted. There are directions which specify two components, for example and replace the assembly sequence of the component as modification directions. Moreover, as another example, there are directions which insert a procedure in the order the front stirrup of the components specified independently instructed the components for modification to be later after carrying out sequential directions, plurality and.

[0057] The example of activation of the assembly-sequence edit approach shown in drawing 59 - drawing 63 by drawing 58 is shown. Drawing 59 is the example of the configuration data inputted by processing 5801. An assembly consists of four components of components 5901, 5902, 5903, and 5904 in this example. Drawing 60 is the example of the assembly procedure data inputted by processing 5802. This assembly procedure data expresses the assembly procedure which places components 5901 first, then attaches components 5902 from -Y shaft orientations, then attaches components 5903 from -Y shaft orientations, and finally attaches components 5904 from -Y. Drawing 61 is the exploded view generated by processing 5801 and processing 5804. The assembly procedure modification menu 6101 is displayed by processing 5805, and a user changes with a mouse and chooses a command 6102. Control moves to processing 5806 by this, and modification directions are inputted. For example, in the case of an exchange command, two components 5903 and components 5904 are directed. If it does so, the sequence of the components 5902 in assembly procedure data and components 5903 will be replaced by processing 5807. The assembly procedure data after changing into drawing 62 are shown. The result which calculated the arrangement location by processing 5803 using the

configuration data inputted by the assembly procedure data after modification and processing 5801, and was displayed by processing 5804 becomes like drawing 63 . The assembly procedure modification menu 6101 is again displayed by processing 5805 after displaying the exploded view after modification. Here, a user will input modification directions by processing 5806, if the migration command 6103 is chosen. In the case of a migration command, the components for sequence migration and the components of a migration place are directed on an exploded view, and it directs with a menu whether to move in front of migration place components, or move to behind in it. For example, on drawing 63 , it directs in order of components 5903 and components 5904 as sequence modification components, and then 5902 is directed as migration place components. And a "front" is chosen from a menu 6301. In processing 5807, according to the modification directions inputted by processing 5806, components 5903 and components 5904 are moved in front of components 5902 in this order, consequently assembly procedure data like drawing 64 are obtained. If an arrangement location is calculated by processing 5803 and it displays by processing 5804 based on the assembly procedure data of drawing 64 , the configuration data of drawing 5959 , and arrangement data, an exploded view as shown in drawing 6565 will be obtained. When it is not necessary to display a menu 6101 by processing 5805 and a user does not need to change an assembly sequence any more, termination 6104 is chosen and edit processing is ended.

[0058] Thus, on an exploded view, while directions of components will become easy since components are disassembled if an assembly procedure is directed on an exploded view, since components are located in a line in order of the assembly sequence, grasp of the assembly sequence of components becomes easy. Therefore, it is easier to change an assembly sequence on an exploded view rather than it changes sequence in the state of assembly completion.

[0059] As mentioned above, if there are configuration data and assembly procedure data at least, since the automatic creation of the exploded view can be carried out according to the example of this invention, it is effective in reducing the man day of exploded view creation.

[0060] Moreover, since what is necessary is just to calculate the inner product of at most six top-most vertices and direction vectors with a group about one component by using the top-most vertices of the bounding box which includes a part shape instead of the top-most vertices of a part shape, or a control point, the effectiveness that an exploded view can be created is in a high speed.

[0061] Furthermore, since the components taken into pieces in the exploded view again by using the direction of a look of an exploded view for movement magnitude count of components with a group can create drawing which does not have a lap seemingly, it is effective in the ability to create the exploded view which is easy to understand.

[0062] Moreover, since drawing which has arranged seemingly the components taken into pieces in the exploded view by movement magnitude count of components with a group requiring with the direction of a look of an exploded view at equal intervals can be created, it is effective in the ability to create the exploded view which is easy to understand.

[0063] Moreover, since the field which contacts in the state of assembly can be connected by the line on an exploded view, it is effective in the ability to create the exploded view the direction of assembly is easier to understand.

[0064] Moreover, since an exploded view can be created easily, assembly procedure data are inputted, the exploded view is displayed, it is seen, the fault of an assembly procedure is found, and it is effective in the activity of correcting assembly procedure data becoming possible by little time and effort, and planning of the assembly procedure in the production process of a product becoming easy.

[0065]

[Effect of the Invention] The activity which according to this invention the automatic creation of an exploded view of was attained and was performed conventionally that an operator directs the migration direction and movement magnitude and moves components one by one becomes unnecessary, and becomes possible [reducing the man day of exploded view creation].

[Translation done.]

* NOTICES *

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TECHNICAL FIELD

[Industrial Application] This invention relates to the equipment and the approach of creating an exploded view by which it is created in case the assembly procedure in the structure and the production process of an assembly which consist of two or more components, and the procedure of maintenance check or repair are shown.

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PRIOR ART

[Description of the Prior Art] An exploded view is a drawing which took each components into pieces from the condition of having combined components, and has been arranged in order of assembly in the direction contrary to a direction with a group. Such an exploded view is used when the assembly procedure in the configuration and production process of an assembly which consist of two or more components, maintenance check, the procedure of repair, etc. are shown. Conventionally, the exploded view was created in handwriting based on the assembly procedure which showed a working drawing, assembly procedures, etc., such as assembly drawing of a product, and part drawing. Moreover, in recent years, when a user moves components with a migration command in consideration of an assembly procedure based on the data which the CAD system was used for the product design, created the assembly model of the product created using the 3-dimensional CAD system, and created by this 3-dimensional CAD system, the exploded view is created.

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EFFECT OF THE INVENTION

[Effect of the Invention] The activity which according to this invention the automatic creation of an exploded view of was attained and was performed conventionally that an operator directs the migration direction and movement magnitude and moves components one by one becomes unnecessary, and becomes possible [reducing the man day of exploded view creation].

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] With the above-mentioned conventional technique, since the exploded view was created with the help, it took time amount very much. Moreover, when using the configuration data of the assembly created by the 3-dimensional CAD system, the configuration of components did not need to be written at least, but in order for an operator to direct the migration direction and movement magnitude and to move components one by one, it took time and effort. Moreover, in a manufacture preparation phase, in the phase where the assembly procedure is examined, an assembly procedure needs to look at whether it is the right, and needs to check a configuration. However, with trial-and-error, whenever it changes a procedure, in order to remake an exploded view for the decision of an assembly procedure with a help, there was a problem that a man day started very much in it.
[0004] The purpose of this invention is to offer the equipment and the approach of creating easily the exploded view which can check an assembly procedure easily.

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MEANS

[Means for Solving the Problem] In what has the operation part by which this invention displays an assembly on a display as the input section and the configuration data memory which memorizes the configuration data of the components with which an assembly is constituted based on said configuration data A means by which an erector determines the arrangement location of the decomposition condition of the components which constitute said assembly based on data and said configuration data is established, and the description is shown in having displayed the exploded view on said display according to this determined arrangement location.
[0006] Data specifically consist [the assembly sequence of components, and] of assembly like said erector. Said arrangement positioning means The inner product of the top-most-vertices coordinate of the components in configuration data memory and the direction vector of assembly is calculated. While calculating the minimum value of the inner product value, the inner product of said top-most-vertices coordinate of components and direction vector of assembly which were read is calculated. The maximum of that inner product value is calculated, spacing between each part articles at the time of changing into a decomposition condition the components which constitute said assembly based on the difference for which it asked on an exploded view is determined, and an exploded view is displayed on said display according to this determined components spacing.

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OPERATION

[Function] According to this invention, the inner product of the top-most-vertices coordinate of the components in configuration data memory and the direction vector of assembly calculates by the arrangement positioning means. While the minimum value of the inner product value is calculated, the inner product of said top-most-vertices coordinate of components and direction vector of assembly which were read calculates. Spacing between each part articles at the time of changing the components with which the maximum of the inner product value is calculated, and constitutes said assembly based on the called-for difference into a decomposition condition on an exploded view is determined. Since an exploded view is displayed on a display according to this determined components spacing Automatic creation of an exploded view is attained, the activity currently done conventionally that an operator directs the migration direction and movement magnitude and moves components one by one becomes unnecessary, and it becomes possible to reduce the man day of exploded view creation.

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EXAMPLE

[Example] One example of the configuration of the exploded view listing device by this invention is shown in drawing 1 . An input device 101 consists of equipment which receives data from alien machines, such as the device and communication device which incorporate the directions from users, such as a keyboard and a mouse, and a floppy disk drive unit. An arithmetic unit 102 is constituted from a CPU, the data in a store 103 are calculated by the program memorized by the store 103, or data with an input device 101 and an output unit 104 are exchanged. A store 103 is constituted from RAM, a magnetic disk, etc., and memorizes a program and data. An output unit 104 consists of devices which deliver data to alien machines, such as indicating equipments, such as CRT, a communication device, and a floppy disk drive unit.
[0009] The configuration data 105, the assembly procedure data 106, the configuration data input program 107, the assembly procedure input program 108, the components migration program 109 with a group, and the exploded view display program 110 are stored in a store 103. The configuration data 105 memorize the geometric information on an assembly. The assembly procedure data 106 memorize the components 111 with a group, and the direction 112 with a group for every sequence of assembly. The configuration data input program 107 incorporates the geometric information on an assembly from an input device 101, and stores it in the configuration data 105. An assembly procedure input program incorporates components with a group, and a direction with a group for every sequence of assembly from an input device 101, and stores them in the assembly procedure data 106. In a certain assembly procedure step, from the configuration data of the components 111 with a group, the configuration data of components [finishing / attachment / already], and the direction 112 with a group, the components migration program 109 with a group calculates the components location with a group on an exploded view, and changes the components location of the components with a group in the configuration data 105. The exploded view display program 110 outputs the configuration data 105 to an output unit 104.
[0010] A user inputs the input of the configuration data 105 and the assembly procedure data 106 using a mouse and a keyboard, or it inputs the data which created data through a network, a floppy disk, etc. by the alien machine.
[0011] An example of the exploded view creation approach in this example is shown in drawing 43 . In processing 4301, the arrangement location of the components in the configuration data and the assembly completion condition of components which are set as the object of assembly is incorporated. In processing 4302, the assembly procedure data which consist of an assembly sequence of components and data of the direction of assembly are incorporated. In processing 4303, the arrangement location in the condition of the part shape, the arrangement location, the assembly sequence, and having decomposed from assembly about each components which constitute an assembly is calculated. In processing 4304, a part shape is displayed based on the arrangement location for which it asked by processing 4303.
[0012] The detailed configuration of one example of the components migration program 109 with a group is shown in drawing 2 . The procedure sequential readout program 201 reads the assembly procedure step of each in the assembly procedure data 106, and stores it in the components memory 202 with a group, and the direction memory 208 with a group. The direction 112 with a group expresses the direction of [when attaching components with a group to components / finishing / assembly / already], and expresses it with a unit

vector. It is Va about this. It carries out. Moreover, the finishing components memory 204 with a group stores the list of components attached by the procedure step before a certain assembly procedure step. The inner product minimum value count program 205 is attached from the finishing components memory 204 with a group, reads the list of ending components, calculates the top-most vertices of those components, and the inner product of the installation direction, and calculates the minimum value in it. It is Dmin about this. It carries out. The inner product maximum count program 206 reads the components attached from the components memory 202 with a group, and takes out the coordinate value of the top-most vertices of those components from the configuration data 105. The inner product of those coordinate values and a direction with a group is calculated, respectively, and the maximum in it is calculated. It is Dmax about this. It carries out. The components repositioning program 207 with a group asks for movement vector V of components with a group by the following formulas (1). However, Dconst It is the clearance between the constant rates defined beforehand.

[0013]

[Equation 1]

V=(Dmin-Dmax-Dconst) *Va -- (1)

And it is the location Mo of components with a group from configuration data. It takes out and writes in configuration data by making into a new components location the value M to which the migration matrix Mv searched for from movement vector V was applied. This count is based on the following formulas (2).

[0014]

[Equation 2]

M=Mv*Mo -- (2)

The finishing components addition program 208 with a group adds the components with a group which changed the location to the finishing components memory 204 with a group.

[0015] Next, the principle in which the components migration program 109 with a group creates an exploded view using a concrete example is explained.

[0016] Drawing 3 shows the condition that two components 301 and 302 were assembled. Components 301 consider as finishing components with a group, and components 302 consider as components with a group. The vector 303 shows the direction with a group of components 302. In the inner product minimum value count program 205, the coordinate value of the top-most vertices of the finishing components 301 with a group and the minimum value of the inner product of the direction 303 with a group are calculated. In the example of drawing 3 , an inner product with top-most vertices 401 becomes min, and the value is set to 402 as shown in drawing 4 . That is, when the configuration of the finishing components 301 with a group considers the direction 303 with a group as the number line, it will exist in a larger field than the minimum value 402 of an inner product. On the other hand, in the inner product maximum count program 206, the maximum of the inner product of the coordinate value of the top-most vertices of the components 302 with a group and the direction 303 with a group is calculated. In the example of drawing 3 , the inner product of top-most vertices 403 and a direction with a group serves as max, and the value is set to 404 as shown in drawing 4 . That is, when the configuration of the components 302 with a group considers the direction 303 with a group as the number line, it will exist in a field smaller than the maximum 404 of an inner product. If maximum 404 is lengthened from the minimum value 402, the value will become like 405, and when only the part of 405 moves components with a group in the direction with a group, each existence region on the number line of the direction 303 with a group of the finishing components 301 with a group and the components 302 with a group stops therefore, lapping. However, since the field has touched the way things stand, movement magnitude will be set to 502 if the constant rate 501 beforehand defined from the value of 405 is subtracted like drawing 5 . If only movement magnitude 502 carries out the parallel displacement of the components 302 with a group to the direction 303 with a group, the exploded view with which the finishing section 301 with a group and the components 302 with a group were separated will be obtained.

[0017] The processing flow of a components migration program with a group is shown in drawing 6 . Let the components with a group of the 1st procedure step in assembly procedure data be finishing components with a group in processing 601. In processing 602, processing 603 - processing 607 are applied one by one about

the last procedure step from the 2nd procedure step. In processing 603, the current components with a group and the current direction with a group of a procedure step are read from procedure data with a group. In processing 604, all the top-most-vertices coordinates of components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a group are calculated, and the maximum in the value is calculated. In processing 605, all the top-most-vertices coordinates of finishing components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a group are calculated, and the minimum value in the value is calculated. In processing 606, the location of components with a group is moved by the vector obtained applying a direction with a group to the value which lengthened maximum from the minimum value and subtracted the constant rate further. In processing 607, the components with a group which moved and changed into the decomposition condition are added to finishing components with a group.

[0018] Next, signs that an exploded view is created by the processing flow of drawing 6 are explained using a concrete example. Drawing 7 R> 7 shows the configuration of the assembly used for explanation. Components 702 are fixed to a plate 701 with a bolt 703, and, as for the structure of an assembly, components 704 are being fixed to the plate 701 with the bolt 705. The direction with a group of the direction vector 706, components 704, and a bolt 705 of the direction with a group of components 702 and a bolt 703 is the direction vector 707.

[0019] The assembly procedure data of the assembly of drawing 7 become like drawing 8 . A procedure step 801 is the sequence number of an assembly procedure, and performs assembly to this numerical order. The components 802 with a group express the components attached in a certain procedure step. The components shown in drawing 8 correspond to the sign attached to the components of drawing 7 . The direction 803 with a group is a direction vector showing the direction with a group of the components in a certain procedure step. The direction with a group shown in drawing 8 R> 8 corresponds to the sign attached to the direction vector with a group of drawing 7 . In addition, since the 1st procedure step 804 is the case where components are placed first, it does not need to specify a direction with a group.

[0020] First, let the components 701 with a group of the 1st procedure step 804 be assembly finishing components by processing 601. In this phase, it is still the assembly condition of drawing 7 . In addition, on explanation, in order to distinguish components with a group, and finishing components with a group, shading shows finishing components with a group and hatching of a slash shows components with a group. In the state of drawing 7 , components 701 are finishing components with a group. Next, processings 603-607 are repeated and applied by procedure steps 2-5 by processing 602. If processing 603 is performed to the 2nd procedure step 805, the components with a group will be set to 702. This condition is shown in drawing 9 . If processing 604 is performed and the maximum 901 of an inner product will perform processing 605, the minimum value 902 of an inner product will be obtained, if processing 606 is performed, the difference of the minimum value and maximum will be set to 903, if the clearance between constant rates is set to 904, a movement vector 905 will be obtained, and the location of the components 702 after migration is set to 906. If processing 607 is performed, the components 702 which were components with a group will turn into finishing components with a group in the location of 906. A situation while performing processing 603 - processing 607 to the 3rd procedure step 806 is shown in drawing 10 . The components with a group are bolts 703 and the direction vector with a group is 706. Since the components with a group are bolts 703 when processing 604 is performed, the maximum of an inner product is set to 1001. Since the finishing components with a group are components 701 and components 702 when processing 605 is performed, the minimum value of an inner product is set to 1002. The value 1003 which subtracted 1001 from 1002 is acquired, and it will become the location of 1006 if 703 which is components with a group is moved to the direction 706 with a group with the value 1005 which lengthened constant value 1004 from now on. And components 703 turn into finishing components with a group in the location of 1006. A situation while performing processing 603 - processing 607 to the 4th procedure step 807 is similarly shown in drawing 11 . In this case, the maximum and the minimum value of an inner product are equal, and become like 1101 of drawing 11 . Therefore, movement magnitude is set to 1102 for a clearance. Therefore, the location of the components 704 after migration is set to 1103. Furthermore, a situation while performing processing 603 - processing 607 to the 5th procedure step 808 is

shown in drawing 12 . Movement magnitude will be set to 1205 if, as for the difference of 1202, the minimum value, and maximum, the minimum value of the top-most vertices of 1201 and the finishing components 701-704 with a group and the inner product of the direction 707 with a group sets 1203 and a clearance to 1204 in the maximum of the top-most vertices of the components 705 with a group, and the inner product of the direction 707 with a group. Therefore, the location of the components 705 after migration is set to 1206. The appearance of the configuration data after processing termination is shown in drawing 13 . An exploded view is obtained by displaying this.

[0021] Although two dimensions explained at this example, this is realizable as it is also by three dimensions with this invention. For example, in drawing 14 , 1402 and a direction with a group are set [components with a group] to 1403 of the direction of facing down for 1401 and finishing components with a group. The maximum of the inner product of the direction 1403 with a group and the top-most-vertices coordinate of the components 1401 with a group is set to 1404. Moreover, the minimum value of the inner product of the direction 1403 with a group and the top-most-vertices coordinate of the finishing components 1402 with a group is set to 1405. The thing 1407 which lengthened maximum 1405 from the minimum value 1404, and lengthened a part for a clearance 1406 further serves as a movement vector of components with a group. Configuration data after moving the components 1402 with a group to drawing 15 by the movement vector are shown.

[0022] Moreover, in the above-mentioned example, although the inner product of the top-most vertices of components with a group and components with a group-ed and a direction vector with a group was calculated, if the control point of a curve and a curved surface is also made into the object of inner product count when a curved surface is included in components, the more intelligible exploded view of the components which touch on a curved surface can be created. In drawing 16 , 1601 and components with a group-ed are set to 1602 for components with a group. When the curved surface 1603 is included in components with a group, and components with a group-ed, also let the control points 1605 and 1606 of a curved surface 1603 be the objects of count with the coordinate of top-most vertices 1607 and 1608 in the inner product ******** case with the direction vector 1609 with a group. Consequently, the coordinate value of the top-most vertices and the control point of the components 1601 with a group and the maximum of an inner product with the direction vector 1609 with a group turn into a coordinate value of top-most vertices 1608, and the inner product value 1610 of the direction vector 1609. Moreover, the coordinate value of the top-most vertices and the control point of the components 1602 with a group-ed and the minimum value of an inner product with the direction vector 1609 with a group turn into a coordinate value of a control point 1605, and the inner product value 1611 of the direction vector 1609. The value 1613 which subtracted the amount 1612 of clearances serves as movement magnitude of the components 1601 with a group from the difference of the minimum value 1611 and maximum 1610. The configuration data after moving to drawing 17 are shown. Thus, although all components including a curve or a curved surface are inseparable only with a top-most-vertices coordinate, the exploded view which separated all the components can be created by using the control point of a curve or a curved surface.

[0023] In other examples of this invention, the top-most vertices of the bounding box which is the polygon which includes a part shape are used instead of the top-most vertices of the configuration data of components, or a control point. The configuration of the components movement magnitude count program 109 with a group which realizes this example to drawing 18 R> 8 is shown. This program adds the bounding box count program 1801 to the components movement magnitude count program 109 with a group shown in drawing 2 . The bounding box count program 1801 asks for the polygon which includes a part shape with reference to the configuration data 105. The inner product minimum value count program 205 reads the bounding box corresponding to the components memorized by the finishing components memory 204 with a group from the bounding box count program 1801, calculates an inner product with the direction vector with a group memorized one by one by a top-most-vertices coordinate and the direction memory 208 with a group, and calculates the minimum value out of them. The inner product maximum count program 206 reads the bounding box corresponding to the components memorized by the finishing components memory 204 with a group from the bounding box count program 1801, calculates an inner product with the direction vector with a

group memorized by each top-most-vertices coordinate and the direction memory 208 with a group, and calculates maximum out of them. The part of others of drawing 18 is the same as that of drawing 2 .
[0024] The bounding box which is the polygon which includes a part shape is the cube 1902 parallel to the axis of coordinates 1901 of components system of coordinates as shown in drawing 19 , or assembly system of coordinates. Such a bounding box is calculable by calculating the maximum of the direction of a x axis of the coordinate value of top-most vertices or a control point, the minimum value and the maximum of the direction of the y-axis, the minimum value and the maximum of the direction of the z-axis, and the minimum value which constitute a part shape, respectively. Before count of a bounding box calculates movement magnitude, it may follow the bounding box of all components beforehand, or may be set, and it may be performed during movement magnitude count. Moreover, you may include in the configuration data 105. At this time, the bounding box count program 1801 becomes unnecessary. The exploded view which separated all the components since it became surely larger than the movement magnitude which calculated the movement magnitude of components with a group using the coordinate of top-most vertices or a control point since the bounding box includes the part shape completely can be created.
[0025] In addition, here explains this example using a bounding box concretely below. Drawing 44 is a flow chart which shows the procedure of opting for the components arrangement on an exploded view. In processing 4401, the arrangement location of the components in the configuration data and the assembly completion condition of components which are set as the object of assembly is incorporated. In processing 4402, the assembly procedure data which consist of an assembly sequence of components and data of the direction of assembly are incorporated. In processing 4403, after emptying the part list with a group-ed which is a list of components [finishing with a group], the 1st component with a group of assembly procedure data is set to a part list with a group-ed. In processing 4404, processing 4405 - processing 4409 are repeated in order of an assembly sequence about the last components with a group from the 2nd components with a group of assembly procedure data. The bounding box of components with a group is computed in processing 4405. Next, in processing 4406, the bounding box which includes all the components contained in a part list with a group-ed is computed. In processing 4407, the movement magnitude of components with a group with which each other bounding box adjoins is calculated from the bounding box of a direction with a group, and components with a group, and the bounding box of components with a group-ed. In processing 4408, only the movement magnitude calculated by processing 4407 moves components with a group to a direction with a group, and an opposite direction. In processing 4409, the components name with a group which migration finished is added to a part list with a group-ed.
[0026] The detailed flow chart of processing 4407 is shown in drawing 45 . In processing 4501, each top-most vertices of the bounding box of components with a group are made into the starting point, and the half-line prolonged in the opposite direction of a direction with a group is drawn. In the case of two dimensions, four half-lines can be drawn. In the case of three dimensions, six half-lines can be drawn. It asks for the intersection of the half-line and the bounding box of components with a group-ed which were created by processing 4501 in processing 4502. When one half-line has the bounding box of components with a group-ed, and two intersections, let the more distant one from the starting point be an intersection. In processing 4503, the distance from the starting point to an intersection is computed about each half-line. Distance is set to 0 when there is no intersection. In processing 4504, maximum is chosen among the distance found by processing 4503, and let it be movement magnitude.
[0027] The example of activation of the exploded view creation by this example is shown in drawing 46 - drawing 48 . Drawing 46 is the drawing of the completion condition of the assembly for explanation. It has the structure where the bolt 4602 is being fixed to the plate 4601. A bolt 4602 presupposes that components with a group and a plate 4601 is [the direction with a group of a bolt 4602] 4603 with components with a group-ed. Processing is explained illustrating information used for drawing 47 R> 7 in the middle of count, such as a bounding box and a half-line. The bounding box 4701 of components with a group-ed and the bounding box 4702 of components with a group are first computed by processing 4405 and processing 4406. Next, processing 4501 draws out half-lines 4707, 4708, 4709, and 4710 to the direction 4603 with a group, and an opposite direction from the top-most vertices 4703, 4704, 4705, and 4706 of the bounding box 4702 of

components with a group. Next, the intersections 4711, 4712, 4713, and 4714 of the bounding box 4701 of half-lines 4707, 4708, 4709, and 4710 and components with a group-ed are computed by processing 4502. Next, the distance between the starting point and an intersection, i.e., top-most vertices 4703 - an intersection 4711, top-most vertices 4704 - an intersection 4712, top-most vertices 4705 - an intersection 4713, top-most vertices 4706 - an intersection 4714 are computed by processing 4503. Furthermore, in the case of maximum, therefore drawing 47 , let distance of top-most vertices 4703 - an intersection 4711 be movement magnitude among the distance between the starting point and an intersection by processing 4504. Drawing 48 shows the condition of having moved the components 4602 with a group to the direction 4603 with a group, and the opposite direction with the movement magnitude 4801 computed by processing 4408. Thus, if the movement magnitude calculated by the processing flow shown in drawing 45 is used, components with a group can be arranged in the location with which the bounding box of components with a group and components with a group-ed does not lap, therefore components with a group and components with a group-ed can be separated, and components can be arranged. If this is applied in order of the assembly procedure, the exploded view of the whole assembly can be created automatically.

[0028] The example of further others of this invention is shown below. In the exploded view listing device of drawing 1 , drawing 2020 is a functional block diagram changed into the exploded view display program 2003 which displayed the exploded view display program 110 on the components migration program 2002 with a group which took the direction of a look into consideration for the components migration program 109 with a group in the direction of a look into which it was inputted by the direction input program 2001 of a look while adding the direction input program 2001 of a look. The direction input program 2001 of a look incorporates directions and other programs of a user, and the look vector from a calculating machine from an input device 101. From the direction input program 2001 of a look, the components migration program 2002 with a group in consideration of the direction of a look changes the location of the components which determined the movement magnitude of components from reception, and the configuration data 105, the assembly procedure data 106 and the direction vector of a look of an assembly, and read the direction vector of a look from the configuration data 105, and writes it in configuration data.

[0029] The block diagram of one example of the components migration program 2002 with a group which took the direction of a look into consideration to drawing 21 is shown. The procedure sequential readout program 201 reads the assembly procedure step of each in the assembly procedure data 106, and stores it in the components memory 202 with a group, and the direction memory 208 with a group. The direction 112 with a group expresses the direction of [when attaching components with a group to components / finishing / assembly / already], and expresses it with a unit vector. It is Va about this. It carries out. Moreover, the finishing components memory 204 with a group stores the list of components attached by the procedure step before a certain assembly procedure step. The projection program 2101 to the flat surface which makes the direction of a look a normal is the direction vector Ve of a look from the direction input program 2001 of a look. The direction vector Va with a group is read from reception and the direction memory 208 with a group, and it is the direction Ve of a look by the following formulas (3). Direction vector Va with a group to the flat surface made into a normal vector Projection vector **** It calculates.

[0030]

[Equation 3]

****=(VexVa)/|VexVa|xVe -- (3)

It attaches from the finishing components memory 204 with a group, the list of ending components is read, and the inner product minimum value count program 2102 is the top-most vertices of those components, and the projection vector ****. An inner product is calculated and the minimum value in it is calculated. It is Dmin about this. It carries out. The inner product maximum count program 2103 reads the components attached from the components memory 202 with a group, and takes out the coordinate value of the top-most vertices of those components from the configuration data 105. Those points and projection vectors **** An inner product is calculated and the maximum in it is calculated. It is Dmax about this. It carries out. The components repositioning program 2104 with a group asks for movement vector V of components with a group by the following formulas (4). However, Dconst It is the clearance between the constant rates defined beforehand.

[0031]
[Equation 4]
V=(Dmin-Dmax-Dconst) *Va/(****-Va) -- (4)
And it is the location Mo of components with a group from the configuration data 105. Migration matrix Mv which was taken out and searched for from movement vector V This count written in the configuration data 105 by making the applied value M into a new components location is based on the following formulas (2).
[0032]
[Equation 5]
M=Mv*Mo -- (2)
The finishing components addition program 208 with a group adds the components with a group which changed the location to the finishing components memory 204 with a group.
[0033] Next, the principle in which the components migration program 2002 with a group creates an exploded view using a concrete example is explained. Drawing 22 shows the condition that two components 2201 and 2202 were assembled. Components 2201 consider as finishing components with a group, and components 2202 consider as components with a group. A vector 2203 is the direction Va with a group of components 2202. It is shown. The direction vector Ve of a look In drawing 22 , it considers as the direction of [from this side] the other side at right angles to space. Drawing 23 is the direction vector Ve of a look. Direction vector Va with a group It is drawing which looked at the assembly of drawing 22 from the perpendicular direction. a vector 2301 -- the direction vector Ve of a look it is . Direction vector Vt perpendicular to the space of drawing 23 The direction vector Ve of a look A perpendicular and direction vector Va with a group Since it is perpendicular, it is the direction vector Ve of a look. Direction vector Va with a group It is the vector which normalized the vector calculated by the outer product. Therefore, Vt It asks by the following formulas (5).
[0034]
[Equation 6]
Vt=(VexVa)/|VexVa| -- (5)
However, Vt It considers as the vector 2302 which goes to the other side from this side in drawing 23 .
[0035] The direction Ve of a look Direction vector Va with a group to the flat surface made into a normal vector Projection vector **** In drawing 23 , it becomes the direction vector 2303. Projection vector **** Vt A perpendicular and the direction Ve of a look Since it is perpendicular, it is Vt. Ve It is the vector calculated by the outer product. However, Vt Ve Since it intersects perpendicularly, it is not necessary to normalize. If the above is summarized, it is the projection vector ****. It asks by the following formulas (6).
[0036]
[Equation 7]
****=VtxVe=(VexVa)/|VexVa|xVe -- (6)
In the inner product minimum value count program 2102, the coordinate value of the top-most vertices of the attached components 2201 and the minimum value of the inner product of the projection vector 2303 are calculated. In the example of drawing 22 , an inner product with top-most vertices 2304 becomes min, and the value is set to 2305 as shown in drawing 23 . On the other hand, in the inner product maximum count program 2103, the maximum of the inner product of the coordinate value of the top-most vertices of the components 2202 with a group and the projection vector 2303 is calculated. In the example of drawing 22 , the inner product of top-most vertices 2306 and the projection vector 2303 serves as max, and the value is set to 2307 as shown in drawing 23 . Next, if maximum 2307 is lengthened from the minimum value 2305, the value will become like 2308. It will be set to 2310 if the constant rate 2309 beforehand defined from the value of 2308 is subtracted. Since 2310 is the movement magnitude on a projection vector, it needs to calculate movement magnitude from which the result projected on the projection vector 2303 in the direction 2203 with a group is set to 2310. This should just break the movement magnitude 2310 of projection vector 2303 direction by the inner product of the projection vector 2303 and the ****** vector 2203. Thus, movement magnitude 2311 is calculable. If only movement magnitude 2311 carries out the parallel displacement of the components 2202 with a group in the direction 2203 with a group, it will become like drawing 24 , and if it sees from a look, as drawing 25 shows, an exploded view without the lap parts of the finishing section 2201 with a group and the

components 2202 with a group will be obtained.
[0037] The processing flow of the components migration program with a group which took the direction of a look into consideration to drawing 26 is shown. In processing 2601, the direction vector of a look is incorporated from the direction input program of a look. Let the components with a group of the 1st procedure step in assembly procedure data be finishing components with a group in processing 2602. In processing 2603, processing 2604 - processing 2610 are applied one by one about the last procedure step from the 2nd procedure step. In processing 2604, the current components with a group and the current direction with a group of a procedure step are read from procedure data with a group. In processing 2605, when [parallel] confirming whether the direction of a look and a direction with a group are parallel, since an outer product is set to 0, it considers as an error. By processing 2606, it is the direction **** with a projection group. It calculates by the above-mentioned formula (6). In processing 2607, all the top-most-vertices coordinates of components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a projection group are calculated, and the maximum in the value is calculated. In processing 2608, all the top-most-vertices coordinates of finishing components with a group are read from configuration data, each top-most vertices and the inner product of a direction with a projection group are calculated, and the minimum value in the value is calculated. In processing 2609, the location of components with a group is moved by the vector obtained applying a direction with a group to the value which broke the value which lengthened maximum from the minimum value and subtracted the constant rate further by the inner product of a direction with a group, and a direction with a projection group. If a movement vector is set to V, it will ask by the following formulas (4).
[0038]
[Equation 8]
V=(Dmin-Dmax-Dconst)/(****-Va)*Va -- (4)
However, the minimum value of the inner product which calculated Dmin by processing 2608, and Dmax are the maximum of the inner product for which it asked by processing 2607, and Dconst. The clearance value of a constant rate, and Va A direction vector with a group, and **** The direction vector with a projection group and Va which were calculated by processing 2606 It is the direction vector with a group read by processing 2604. In processing 2610, the components with a group which moved and changed into the decomposition condition are added to finishing components with a group.
[0039] In this example, although the coordinate value of top-most vertices was used for inner product count with a projection vector, when it includes a curved surface, the coordinate value of the control point of a curved surface may also be used with a top-most-vertices coordinate value. Moreover, the top-most-vertices coordinate of the bounding box which is the polyhedron which includes the configuration of components may be used instead of top-most vertices or a control point.
[0040] The detailed configuration 2701 of the example of further others of the components migration program 109 with a group in drawing 1 and drawing 2 is shown in drawing 27 . The procedure sequential readout program 201 reads the assembly procedure step of each in the assembly procedure data 106, and stores it in the components memory 202 with a group, and the direction memory 208 with a group. The direction 112 with a group expresses the direction of [when attaching components with a group to components / finishing / assembly / already], and expresses it with a unit vector. It is Va about this. It carries out. Moreover, the finishing components memory 204 with a group stores the list of components attached by the procedure step before a certain assembly procedure step. The contact surface detection program 2702 reads components with a group from the components memory 202 with a group, reads finishing components with a group from the finishing components memory 204 with a group, and detects the contact surface between components with a group, and finishing components with a group with reference to the configuration data 105.
[0041] The inner product minimum value count program 205 takes out the contact surface of components with a group, and finishing components with a group from the contact surface detection program 2702, calculates the inner product of the top-most vertices and installation direction, and calculates the minimum value in it. It is Dmin about this. It carries out. The inner product maximum count program 206 reads the components attached from the components memory 202 with a group, and takes out the coordinate value of the top-most

vertices of those components from the configuration data 105. The inner product of those points and a direction with a group is calculated, and the maximum in it is calculated. It is Dmax about this. It carries out. The components repositioning program 207 with a group asks for movement vector V of components with a group by the above-mentioned formula (1). And it is the location Mo of components with a group from configuration data. Migration matrix Mv which was taken out and searched for from movement vector V It writes in configuration data by making the applied value M into a new components location. This count is based on the above-mentioned formula (2). The finishing components addition program 208 with a group adds the components with a group which changed the location to the finishing components memory 204 with a group.
[0042] Next, the principle in which the components migration program 109 with a group creates an exploded view using a concrete example is explained. Drawing 28 shows the condition that two components 2801 and 2802 were assembled. Components 2801 consider as finishing components with a group, and components 2802 consider as components with a group. The vector 2803 shows the direction with a group of components 2802. First, the contact surface detection program 2702 detects the contact surface between the finishing components 2801 with a group, and the components 2802 with a group, and as shown in drawing 29 , it acquires the bearing surface 2901 and die face 2902 of ****. In the inner product minimum value count program 205, the minimum value of the inner product of the coordinate value of the top-most vertices of a field 2901 and a field 2902 and the direction 2803 with a group is calculated. In the example of drawing 29 , the top-most vertices 3001 of a field 2901 and the inner product of the direction vector 2803 become min, and the value is set to 3002 as shown in drawing 30 . On the other hand, in the inner product maximum count program 206, the inner product of the coordinate value of the top-most vertices of the components 2802 with a group and the direction 2803 with a group is calculated. In the example of drawing 28 , the inner product of top-most vertices 3003 and the direction 2803 with a group serves as max, and the value is set to 3004 as shown in drawing 30 . Next, maximum 3004 is lengthened from the minimum value 3002, and movement magnitude will be set to 3006 if the constant rate 3005 defined further beforehand is subtracted. If only movement magnitude 3006 carries out the parallel displacement of the components 2802 with a group to the direction 2803 with a group, the exploded view with which the finishing section 2801 with a group like drawing 31 and the components 2802 with a group were separated will be obtained.
[0043] In this example, although the top-most vertices of the contact surface were used for inner product count, a curved surface and a curved control point may also be used for inner product count with top-most vertices. Moreover, it asks for the bounding box which includes the contact surface beforehand instead of the top-most vertices of the contact surface, or a control point, and the top-most vertices of this bounding box may be used for inner product count with a direction vector with a group. Furthermore, a contact surface retrieval program may be included in the components migration program 2002 with a group in consideration of the direction of a look shown in drawing 21 , and the top-most vertices of the contact surface may be used for inner product minimum value count instead of the top-most vertices of components.
[0044] Next, the configuration of the example of further others by this invention is shown in drawing 32 . Drawing 32 adds the tie line creation program 3201 which creates the tie line with which correspondence of the contact surface of components with a group and the contact surface of finishing components with a group is expressed to the components migration program 2701 with a group equipped with the contact surface detection program of drawing 27 . Actuation of the tie line creation program 3201 is explained using drawing 33 and drawing 34 . The tie line creation program 3201 calculates reception, for example, the center of gravity, for the contact surface from the contact surface detection program 2702. In the example of drawing 33 , the contact surface 2901 is passed from the contact surface detection program 2702, and a center of gravity 3301 is searched for. Moreover, the point 3302 that only the movement vector 3006 moved the movement vector 3006 of components with a group from the components repositioning program 207 with a group in the center of gravity 3301 of reception and the contact surface is searched for. And the segment which connects between a point 3301 and points 3302 is added to the configuration data 105. ** [a display of this / display / like drawing 34 / with an exploded view / the tie line 3401 showing correspondence of the contact surface of components with a group and the contact surface of finishing components with a group] Although the alternate long and short dash line expressed the tie line 3401 by drawing 34 , it may be displayed by the size

of a different color from the line showing a configuration, or a line.
[0045] In case the movement vector of components with a group is calculated in the example described so far, it is the clearance Dconst between constant value. Although used, this clearance may be calculated from the direction vector of a look, and a direction vector with a group.
[0046] Drawing 35 shows the example in the case where the clearance between components with a group and finishing components with a group is constant value, and the case of calculating from the direction vector of a look, and a direction vector with a group. Let the direction of a look be a vector 3501. A clearance will be set to 3505 supposing it attaches components 3502 and components 3503 in the direction 3504 with a group. In this case, since the direction 3504 with a group is perpendicular to the direction 3501 of a look, the clearance 3507 on the appearance seen from [3501] the look becomes equal to the actual clearance 3505. However, although a clearance is set to 3511 and it is the same magnitude as 3505 when attaching components 3508 and components 3509 in the direction 3510 of assembly, the apparent clearance 3512 seen from [3501] the look becomes small compared with 3507. If an apparent clearance becomes small, components will be able to approach and it will become unclear as an exploded view. An apparent clearance becomes so small that a direction with a group and the direction of a look approach in parallel. Then, for example, clearance Dconst It calculates like a degree type (7).
[0047]
[Equation 9]

$$D_{const}=\frac{C}{\sqrt{1-(V_a \cdot V_e)^2}} \qquad \cdots (7)$$

[0048] However, Va A direction vector with a group, and Ve The direction vector of a look and C are taken as a forward constant. For example, when attaching the components 3513 and components 3514 in drawing 35 R> 5 in the direction 3515 with a group, for the apparent die length 3517 of the vector 3516 of die length 1 parallel to the direction 3515 with a group, the die length of 3518 is Va. Ve Since it becomes the absolute value of an inner product, it becomes the denominator of the above-mentioned formula (7). Therefore, if a clearance 3519 is calculated by the above-mentioned formula (7), it is not based on the relation between the direction of assembly, and the direction of a look, but sees, and the upper clearance 3520 can be maintained at constant value C.
[0049] Next, depending on the structure of an assembly, it cannot attach one component at a time, but since it may not be assembled if it does not attach after assembling the subassembly which assembled some components, below, an example in case there is a subassembly is explained. First, the example of such an assembly is shown in drawing 49 . The assembly shown in drawing 49 consists of three components of components 4901, 4902, and 4903. In the case of such an assembly, it cannot assemble in order of components 4901, 4902, and 4903. After placing components 4901 first and assembling components 4902 and components 4903, it must attach to components 4901.
[0050] Such assembly procedure data of an assembly can be expressed like drawing 50 . Components level expresses the depth from the root 5101 when expressing the subassembly relation of an assembly with the tree structure, as shown in drawing 51 . Therefore, the level of the subassembly to which, as for 1 and the components level of components 4902 and 4903, the components level of components 4901 assembled 2 and components 4902 and 4903 is set to 1.
[0051] The flow chart of one example of the approach of creating an exploded view from assembly-sequence data which have a subassembly in the middle of the assembly by this invention is shown in drawing 52 . In processing 5201, the configuration data which consist of a components location in the configuration and assembly completion condition of components which constitute an assembly are inputted. In processing 5202, the assembly procedure data which consist of an assembly sequence and components with a group as shown by drawing 50 , the direction of assembly, and components level are inputted. In processing 5203, the 1st component with a group of assembly procedure data is set as a part list with a group-ed. In processing 5204, 5205 or less-processing processing is applied in order about the last components with a group from the 2nd components with a group of assembly procedure data. In processing 5205, components with a group judge

whether they are the components of the beginning of a subassembly. For example, when it expresses a subassembly with components level like drawing 50 , and the components level of components with a group is larger than the components level of the components with a group in front of one, it becomes the components of the beginning of a subassembly, and by processing 5205, it is yes. It branches to the direction and processings 5206 and 5207 are performed. When components level is the same, when smaller than the level of front components with a group, it branches to the direction of no and processings 5208-5211 are performed. In processing 5206, the contents of the current part list with a group-ed are pushed to the stack for the components preservation with a group-ed. In processing 5207, after emptying a part list with a group-ed, current components with a group are set as a part list with a group-ed. By processing 5206 and processing 5207, the information on the components attached until now is saved temporarily, and the preparation which creates the exploded view about the assembly of a subassembly is completed. In processing 5208, the arrangement location of the components with a group in a decomposition condition is calculated from the direction with a group of the configuration data of components with a group, and components with a group-ed, and components with a group. The count approach is as the old example having described. In processing 5209, components with a group are arranged in the arrangement location calculated by processing 5208. In processing 5210, current components with a group judge whether they are the components of the last of subassembly assembly, and if it is the last components, it will branch to processing 5211. When current components with a group are not components of the last of subassembly components, it branches to the direction of no and branches to processing 5212. For example, when it expresses a subassembly with components level like drawing 50 , and the components level of the present components with a group is larger than the level of the components with a group after one, it becomes the components of the last of subassembly assembly. In processing 5211, the components group which carried out pop [of the components with a group-ed pushed at the end], and carried out pop to the stack for the components preservation with a group-ed is set as a current part list with a group-ed. In processing 5212, components with a group are added to a part list with a group-ed. After applying processing 5205 to all the components with a group of assembly procedure data by processing 5204, the configuration data after migration are displayed by processing 5213. Thereby, an exploded view is displayed.

[0052] The stack for the components preservation with a group-ed is realized in the table which consists of a column of a stack pointer 5301 and the components name 5303 as shown in drawing 5353 , and the components number 5302. A stack pointer 5301 saves the number of the part lists with a group-ed stored in the current stack. If a part list with a group-ed is newly pushed, only one stack pointer is added and the list of the number of components and components names is stored in the 3rd line 5304 in the line which made the value of the stack pointer after addition the index, and this case. On the contrary, when carrying out pop from a stack, while taking out the components name list of lines which made the value of a stack pointer 5301 the index, the line is deleted from a table and only one value of a stack pointer 5301 is subtracted. In the example of drawing 53 , since the value of a stack pointer 5301 is 2, the components name C is taken out from the second line 5305, this line 5305 is deleted, one value of a stack pointer 5301 is subtracted, and it is referred to as 1. Thus, the list of components names memorized later can be issued for the beginning.

[0053] The situation of the exploded view creation when applying processing of drawing 52 to the data of drawing 49 and the assembly procedure data of drawing 50 R> 0 is explained using drawing. Configuration data drawing 49 and assembly procedure data drawing 50 are inputted by processings 5201 and 5202. Next, activation of processing 5203 sets the components 4901 with a group of the assembly procedure data of the beginning of drawing 50 as a part list with a group-ed. It confirms whether to be the components of the beginning of subassembly assembly by processing 5205 about the following components 4903 with a group. Although the level of the components 4901 with a group in front of one is 1, it turns out that the components level of the current components 4903 with a group is 2, and it is the beginning of subassembly assembly since the components level of current components with a group is larger. Then, 4901 is stored in the stack for components with a group-ed in the contents of the part list with a group-ed, and this case by processing 5206. And let the current components 4903 with a group be components with a group-ed by processing 5207. Then, a loop formation is carried out by processing 5204, and 5205 or less processing is applied to the

components 4902 with a group. First, it confirms whether to be the beginning of a subassembly by processing 5205. Both the components level of the components 4903 with a group in front of one and the components level of the current components 4902 with a group are the same at 2. Therefore, since it is not the components of the beginning of subassembly assembly, it branches to no, and it progresses to processing 5208. Here, the arrangement location of a decomposition condition is calculated using the configuration data of the components 4902 with a group, and the components 4903 with a group-ed, and the direction data of assembly of the components 4902 with a group. The condition of having moved 4902 by processing 5209 based on the count result is shown in drawing 54 . Next, it investigates whether it is the last of subassembly assembly by processing 5210. The components level of components 4902 is 2, and since the components level of the following components 4902+4903 with a group is 1, they are the components of the last of subassembly assembly. Therefore, yes It branches to the direction, pop [of the components 4901] is carried out from a components stack with a group-ed, and it sets to a part list with a group-ed. Then, a loop formation is carried out by processing 5204, and 5205 or less processing is applied to the components 4902+4903 with a group. In the components 4902+4903 with a group, assembling and attaching two components 4902 and 4903 is shown. In processing 5205, the components level of components 4902+4903 is 1, and the components level of the components 4902 with a group in front of one is 2, and is not the components of the beginning of subassembly assembly. Therefore, it branches to no and progresses to processing 5208. Here, it asks for the location in the condition of having decomposed 4902 and 4903 by using components 4901 as components with a group-ed, having used as components with a group the location and configuration data of 4902 and 4903 of a decomposition condition which were calculated by the front loop formation, and 4902 and 4903 are moved by processing 5209. This condition is shown in drawing 55 . The exploded view of the assembly procedure data which have subassembly assembly as mentioned above can be created.

[0054] Although the example which expresses a subassembly with components level like drawing 50 as assembly procedure data with subassembly assembly was shown, the flag which shows the existence of subassembly assembly to assembly procedure data like drawing 56 is formed, and when a flag is 0, it is good also as those with subassembly assembly at subassembly assembly nothing and the time of 1. The assembly procedure of subassembly assembly prepares and expresses another assembly procedure data like drawing 57 . Correspondence with the components 4904 with a group with the subassembly assembly of drawing 56 and the assembly procedure data of subassembly assembly can take correspondence by investigating coincidence of a components name with a group and a subassembly name by memorizing the subassembly name to assembly procedure data. Such at the time of the expression of assembly procedure data, the judgment of being the beginning of subassembly assembly serves as the case where a subassembly flag is 1. Moreover, the assembly procedure data which are the same subassembly name as a components name with a group are searched, and let the first component with a group be new components with a group-ed. The judgment of being the last of subassembly assembly is judged by whether it reached to the last of the order data of assembly.

[0055] Next, the exploded view listing device shown in drawing 1 shows signs that the assembly procedure of an assembly is created, using a concrete example. Drawing 36 is the structure of the assembly used for explanation. The assembly consists of components 3601, components 3602, components 3603, and components 3604. An example of the assembly procedure which the user inputted into drawing 37 is shown. Components 3601 are placed first, then, components 3602 are attached from the upper part, and then this attaches components 3603 from width, and, finally attaches components 3604 from the upper part. If an exploded view is created by the exploded view listing device according this to this invention, it will become like drawing 37 . For the user who looked at drawing 37 , it is a solution or ** that components 3601 become obstructive and are not attached although it is going to attach components 3603 from width. Since components 3603 are attached in components 3601 only from the upper part, a user gives directions to the assembly procedure input program 108, and changes the installation direction 3901 of components 3603 into installation from the upper part like the assembly procedure of drawing 39 . If an exploded view is created and the components migration program 109 with a group is displayed by the exploded view display program 110 by starting based on the assembly procedure of drawing 39 , it will become like drawing 40 . When drawing 4040 is

seen, for a user, it is a solution or ** that components 3602 become obstructive and components 3603 are not attached since components 3603 are attached after attaching components 3602. Then, a user gives directions to the assembly procedure input program 108, and changes the procedure step 4101 with a group of components 3603 before the assembly procedure step 4102 of components 3602 like the assembly procedure of drawing 41 . If an exploded view is created and the components migration program 109 with a group is displayed by the exploded view display program 110 by starting based on the assembly procedure of drawing 41 , it will become like drawing 42 . When drawing 42 is seen, it is a solution or ** that there is no fault which components collide with in the middle of assembly. Thus, an assembly procedure is inputted and a right assembly procedure is obtained by repeating creating an exploded view.

[0056] In addition, here shows an example of the modification approach of the assembly procedure using the exploded view by this invention to drawing 58 further. The configuration data which consist of a components location in the configuration and assembly completion condition of components which constitute the assembly which creates an exploded view from processing 5801 are inputted. In processing 5802, an assembly sequence, components with a group, and the assembly procedure data that consist of assembly are inputted. In processing 5803, the components location of a decomposition condition is computed from builtup type-like data and assembly procedure data. In processing 5804, a part shape is displayed on the components location in the decomposition condition computed by processing 5803, and it displays as an exploded view. In processing 5805, it is asked to a user whether there is any modification of an assembly procedure. A user inputs the existence of the need for modification using input devices, such as a keyboard and a mouse. When there is no need for modification, procedure modification processing is ended. Processing 5806 is performed when modification is required. Directions of procedure modification are asked to a user in processing 5806. A user inputs components to be changed and the contents of modification using a keyboard or a mouse. The components for [two or more] modification are directed, and assembly procedure data are changed in processing 5807 based on the modification directions which the user inputted. There are directions which specify two components, for example and replace the assembly sequence of the component as modification directions. Moreover, as another example, there are directions which insert a procedure in the order the front stirrup of the components specified independently instructed the components for modification to be later after carrying out sequential directions, plurality and.

[0057] The example of activation of the assembly-sequence edit approach shown in drawing 59 - drawing 63 by drawing 58 is shown. Drawing 59 is the example of the configuration data inputted by processing 5801. An assembly consists of four components of components 5901, 5902, 5903, and 5904 in this example. Drawing 60 is the example of the assembly procedure data inputted by processing 5802. This assembly procedure data expresses the assembly procedure which places components 5901 first, then attaches components 5902 from -Y shaft orientations, then attaches components 5903 from -Y shaft orientations, and finally attaches components 5904 from -Y. Drawing 61 is the exploded view generated by processing 5801 and processing 5804. The assembly procedure modification menu 6101 is displayed by processing 5805, and a user changes with a mouse and chooses a command 6102. Control moves to processing 5806 by this, and modification directions are inputted. For example, in the case of an exchange command, two components 5903 and components 5904 are directed. If it does so, the sequence of the components 5902 in assembly procedure data and components 5903 will be replaced by processing 5807. The assembly procedure data after changing into drawing 62 are shown. The result which calculated the arrangement location by processing 5803 using the configuration data inputted by the assembly procedure data after modification and processing 5801, and was displayed by processing 5804 becomes like drawing 63 . The assembly procedure modification menu 6101 is again displayed by processing 5805 after displaying the exploded view after modification. Here, a user will input modification directions by processing 5806, if the migration command 6103 is chosen. In the case of a migration command, the components for sequence migration and the components of a migration place are directed on an exploded view, and it directs with a menu whether to move in front of migration place components, or move to behind in it. For example, on drawing 63 , it directs in order of components 5903 and components 5904 as sequence modification components, and then 5902 is directed as migration place components. And a "front" is chosen from a menu 6301. In processing 5807, according to the modification

directions inputted by processing 5806, components 5903 and components 5904 are moved in front of components 5902 in this order, consequently assembly procedure data like drawing 64 are obtained. If an arrangement location is calculated by processing 5803 and it displays by processing 5804 based on the assembly procedure data of drawing 64 , the configuration data of drawing 5959 , and arrangement data, an exploded view as shown in drawing 6565 will be obtained. When it is not necessary to display a menu 6101 by processing 5805 and a user does not need to change an assembly sequence any more, termination 6104 is chosen and edit processing is ended.

[0058] Thus, on an exploded view, while directions of components will become easy since components are disassembled if an assembly procedure is directed on an exploded view, since components are located in a line in order of the assembly sequence, grasp of the assembly sequence of components becomes easy. Therefore, it is easier to change an assembly sequence on an exploded view rather than it changes sequence in the state of assembly completion.

[0059] As mentioned above, if there are configuration data and assembly procedure data at least, since the automatic creation of the exploded view can be carried out according to the example of this invention, it is effective in reducing the man day of exploded view creation.

[0060] Moreover, since what is necessary is just to calculate the inner product of at most six top-most vertices and direction vectors with a group about one component by using the top-most vertices of the bounding box which includes a part shape instead of the top-most vertices of a part shape, or a control point, the effectiveness that an exploded view can be created is in a high speed.

[0061] Furthermore, since the components taken into pieces in the exploded view again by using the direction of a look of an exploded view for movement magnitude count of components with a group can create drawing which does not have a lap seemingly, it is effective in the ability to create the exploded view which is easy to understand.

[0062] Moreover, since drawing which has arranged seemingly the components taken into pieces in the exploded view by movement magnitude count of components with a group requiring with the direction of a look of an exploded view at equal intervals can be created, it is effective in the ability to create the exploded view which is easy to understand.

[0063] Moreover, since the field which contacts in the state of assembly can be connected by the line on an exploded view, it is effective in the ability to create the exploded view the direction of assembly is easier to understand.

[0064] Moreover, since an exploded view can be created easily, assembly procedure data are inputted, the exploded view is displayed, it is seen, the fault of an assembly procedure is found, and it is effective in the activity of correcting assembly procedure data becoming possible by little time and effort, and planning of the assembly procedure in the production process of a product becoming easy.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the exploded view listing device which is one example of this invention.
[Drawing 2] It is the detail block diagram of the components migration section with a group in the example of drawing 1 .
[Drawing 3] It is the state diagram of an assembly.
[Drawing 4] It is drawing explaining the principle of operation of the components migration section with a group shown in drawing 2 .
[Drawing 5] It is drawing explaining the principle of operation of the components migration section with a group shown in drawing 2 .
[Drawing 6] It is drawing showing the procedure of the components migration section with a group.
[Drawing 7] It is the state diagram of other assemblies.
[Drawing 8] It is drawing showing the data configuration of assembly procedure data.
[Drawing 9] It is drawing explaining actuation of the components migration section with a group to the assembly shown in drawing 7 .
[Drawing 10] It is drawing explaining actuation of the components migration section with a group to the assembly shown in drawing 7 .
[Drawing 11] It is drawing explaining actuation of the components migration section with a group to the assembly shown in drawing 7 .
[Drawing 12] It is drawing explaining actuation of the components migration section with a group to the assembly shown in drawing 7 .
[Drawing 13] It is the exploded view created according to one example of this invention to the assembly shown in drawing 7 .
[Drawing 14] It is drawing explaining actuation of the components migration section with a group to the assembly of a three-dimensions configuration.
[Drawing 15] It is an exploded view based on the three-dimensions configuration data created according to one example of this invention.
[Drawing 16] It is drawing explaining actuation of one example of the components migration section with a group.
[Drawing 17] It is the exploded view created according to one example of this invention shown in drawing 16 .
[Drawing 18] It is the detail block diagram of the components migration section with a group of the exploded view listing device which are other examples of this invention.
[Drawing 19] It is drawing showing an example of the bounding box which includes a part shape.
[Drawing 20] It is the block diagram of the exploded view listing device which are other examples of this invention.
[Drawing 21] It is the detail block diagram of the components migration section with a group shown in drawing 20 .
[Drawing 22] It is the state diagram of an assembly.
[Drawing 23] It is drawing explaining the actuation of the components migration section with a group shown in

drawing 22 .
[Drawing 24] It is drawing explaining the actuation of the components migration section with a group shown in drawing 22 .
[Drawing 25] It is the exploded view created according to one example of this invention.
[Drawing 26] It is drawing showing the procedure of the components migration section with a group shown in drawing 22 .
[Drawing 27] It is the detail block diagram of the components migration section with a group of the exploded view listing device which are other examples of this invention.
[Drawing 28] It is the state diagram of an assembly.
[Drawing 29] It is drawing showing the example of the contact surface of an assembly.
[Drawing 30] It is drawing explaining the actuation of the components migration section with a group shown in drawing 27 .
[Drawing 31] It is the exploded view created according to one example of this invention.
[Drawing 32] It is the detail block diagram of the components migration section with a group of the exploded view listing device which are other examples of this invention.
[Drawing 33] It is drawing explaining the principle which creates the tie line of the contact surface.
[Drawing 34] It is an exploded view containing the tie line created according to one example of this invention.
[Drawing 35] It is drawing which explains the principle of the approach of determining the clearance between components, according to the direction of a look.
[Drawing 36] It is the state diagram of an assembly.
[Drawing 37] It is drawing showing the data configuration of assembly procedure data.
[Drawing 38] It is the exploded view created with the equipment of one example of this invention.
[Drawing 39] It is drawing showing the data configuration of assembly procedure data.
[Drawing 40] It is the exploded view created with the equipment of one example of this invention.
[Drawing 41] It is drawing showing the data configuration of assembly procedure data.
[Drawing 42] It is the exploded view created with the equipment of one example of this invention.
[Drawing 43] It is the processing flow Fig. of the exploded view creation approach which is one example of this invention.
[Drawing 44] It is the processing flow Fig. of the exploded view creation approach of the example shown in drawing 18 .
[Drawing 45] It is the detail flow Fig. of step 4407 of drawing 44 .
[Drawing 46] It is the state diagram of an assembled product.
[Drawing 47] It is drawing where the bounding box and the half-line were added to the assembled product.
[Drawing 48] It is drawing showing the condition after arrangement spotting.
[Drawing 49] It is drawing showing the configuration data of an assembly with subassembly assembly.
[Drawing 50] It is the data block diagram of assembly procedure data with subassembly assembly.
[Drawing 51] It is drawing which expressed the assembly according to the tree structure.
[Drawing 52] It is drawing showing the procedure of the exploded view creation approach corresponding to the subassembly assembly which is other examples of this invention.
[Drawing 53] It is the data block diagram of the stack for components with a group-ed.
[Drawing 54] It is drawing which expresses a condition in the middle of exploded view creation.
[Drawing 55] It is drawing showing the final state of exploded view creation.
[Drawing 56] It is the data block diagram of assembly procedure data with subassembly assembly.
[Drawing 57] It is the data block diagram of assembly procedure data with subassembly assembly.
[Drawing 58] It is drawing showing the procedure at the time of editing the assembly procedure on the exploded view which are other examples of this invention.
[Drawing 59] It is the state diagram of an assembly.
[Drawing 60] It is the data block diagram of assembly procedure data.
[Drawing 61] It is drawing explaining the directions approach of the assembly procedure edit on an exploded view.

[Drawing 62] It is the data block diagram of the assembly procedure data after assembly procedure edit.
[Drawing 63] It is an exploded view after assembly procedure edit.
[Drawing 64] It is the data block diagram of the assembly procedure data after assembly procedure edit.
[Drawing 65] It is an exploded view after assembly procedure edit.
[Description of Notations]
101 [-- An output unit, 105 / -- Configuration data, 106 / -- Assembly procedure data, 107 / -- A configuration data input program, 108 / -- An assembly procedure input program, 109 / -- A components migration program with a group, 110 / -- An exploded view display program, 111 / -- Components data with a group 112 / -- Direction data with a group.] -- An input device, 102 -- An arithmetic unit, 103 -- A store, 104

[Translation done.]

* NOTICES *

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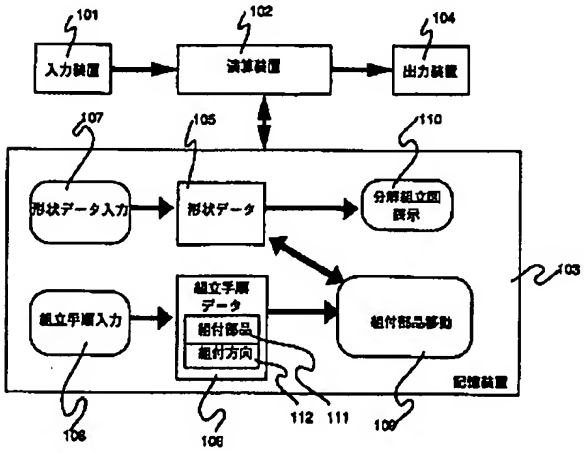
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]

図 1



[Drawing 2]

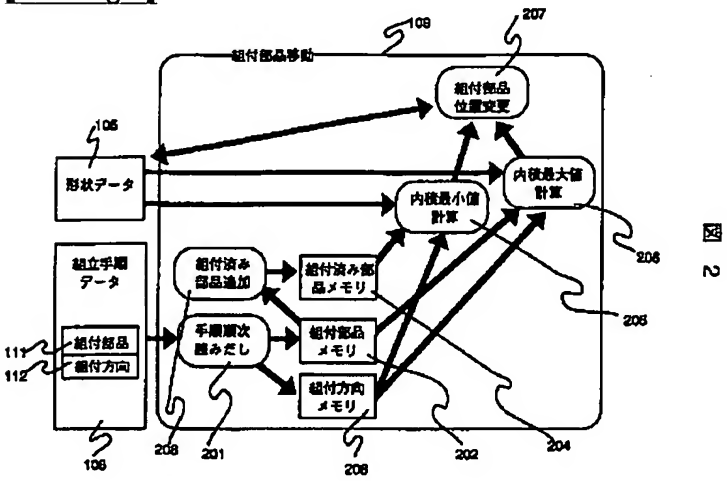
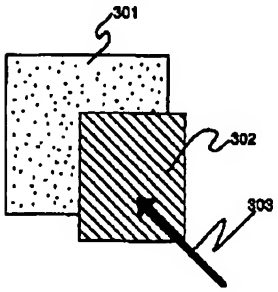


図 2

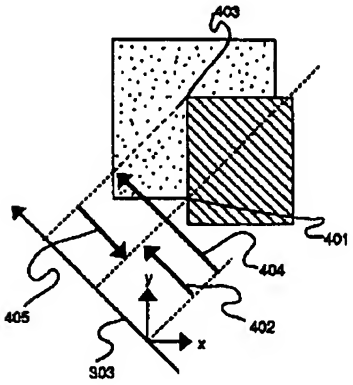
[Drawing 3]

図 3



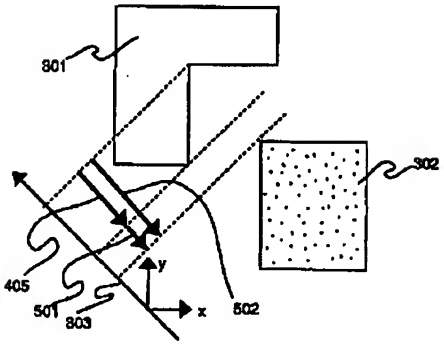
[Drawing 4]

図 4



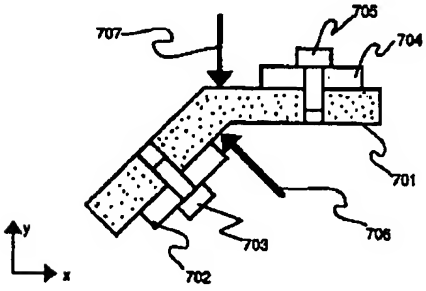
[Drawing 5]

図 5



[Drawing 7]

図 7



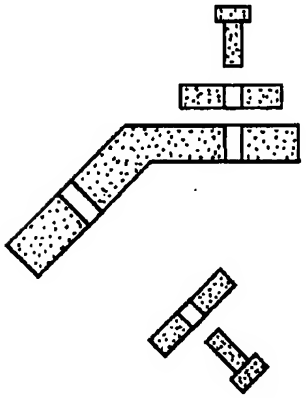
[Drawing 8]

図 8

	801 手順ステップ	802 組付部品	803 組付方向
804	1	701	—
805	2	702	706
806	3	703	706
807	4	704	707
808	5	705	707

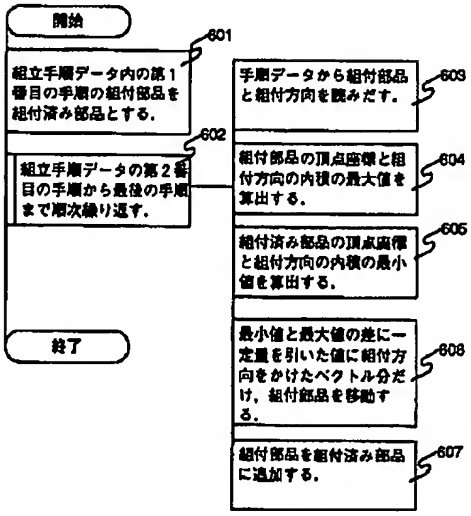
[Drawing 13]

図 13



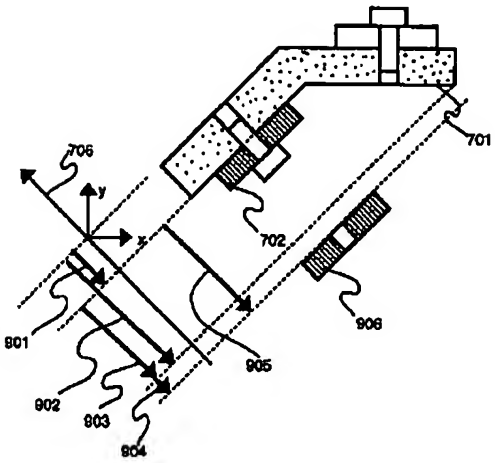
[Drawing 6]

図 6



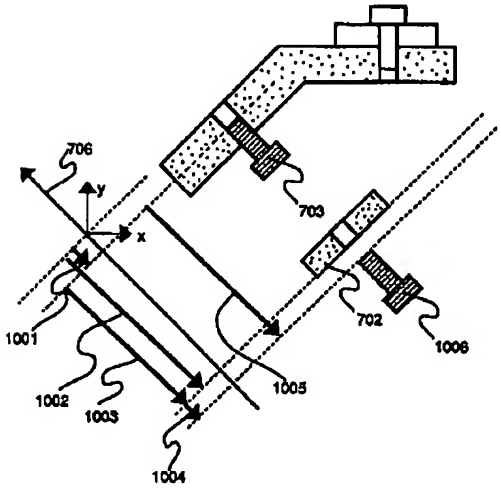
[Drawing 9]

図 9



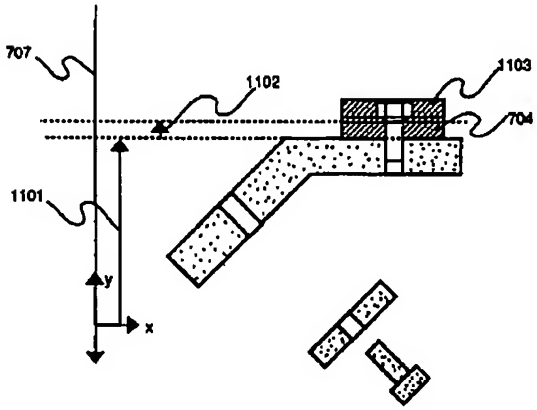
[Drawing 10]

図 10



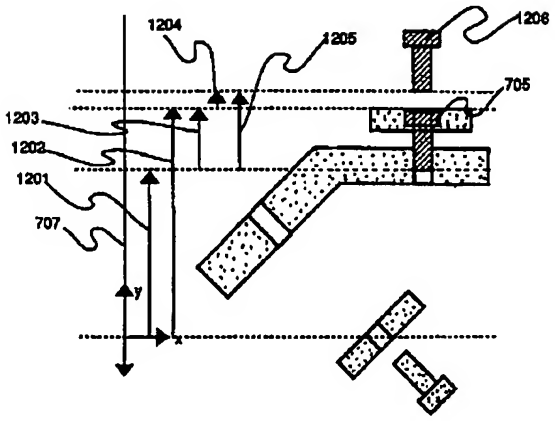
[Drawing 11]

図 11



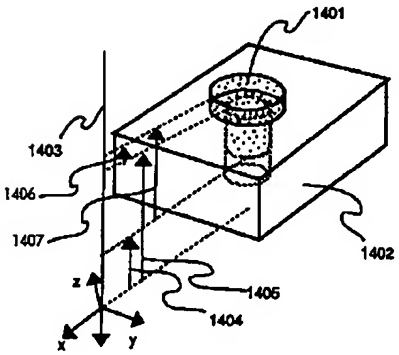
[Drawing 12]

図 12



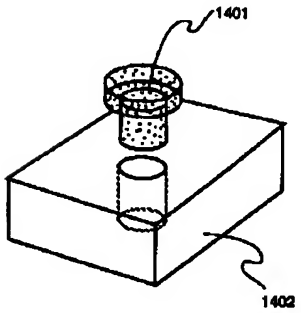
[Drawing 14]

図 14



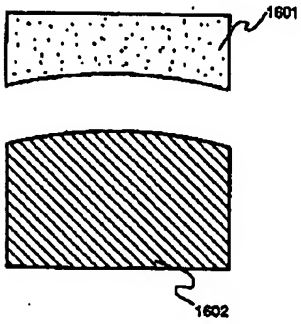
[Drawing 15]

図 15



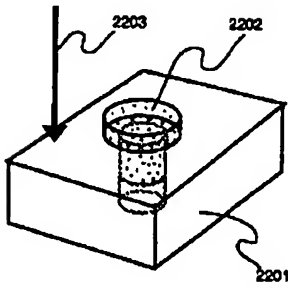
[Drawing 17]

図 17



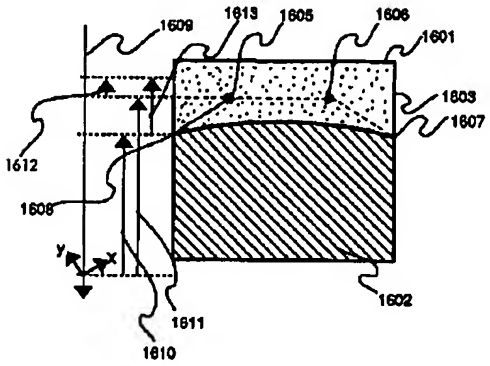
[Drawing 22]

図 22



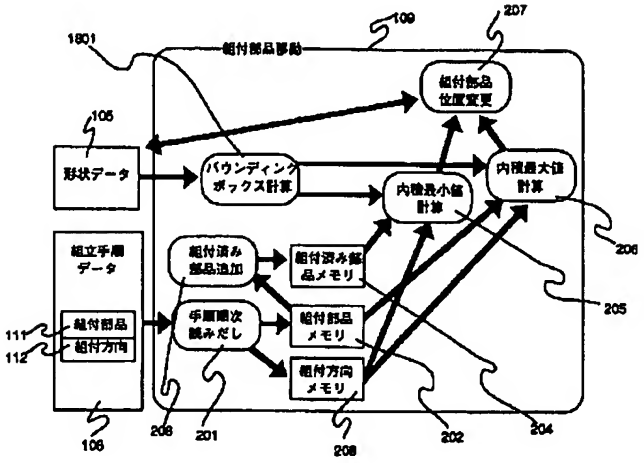
[Drawing 16]

図 16



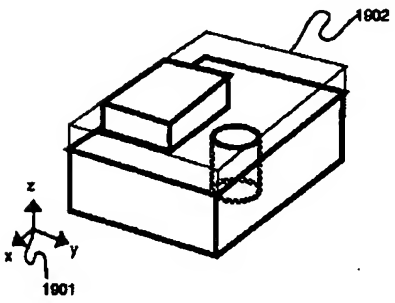
[Drawing 18]

図 18



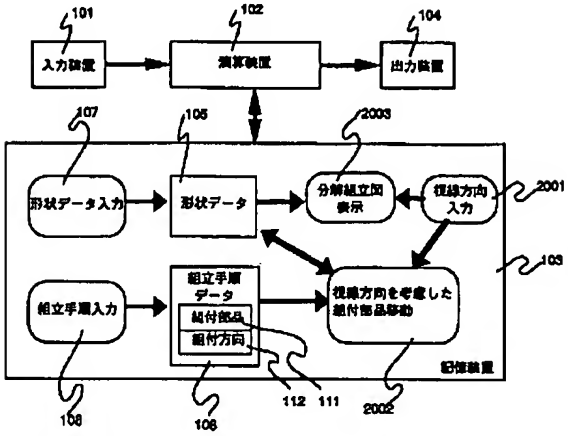
[Drawing 19]

図 19



[Drawing 20]

図 20



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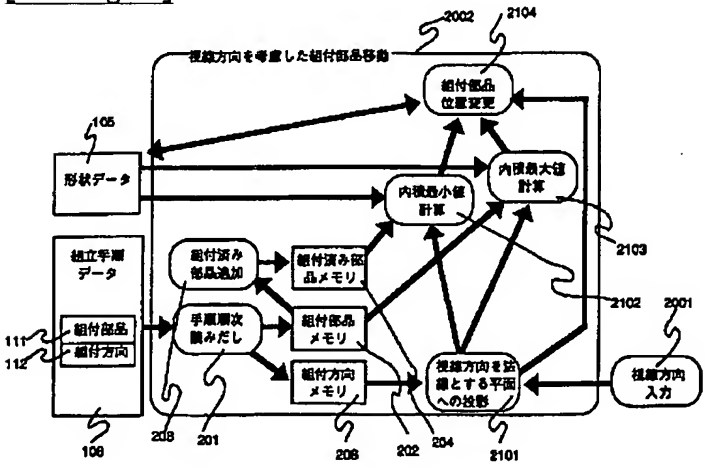
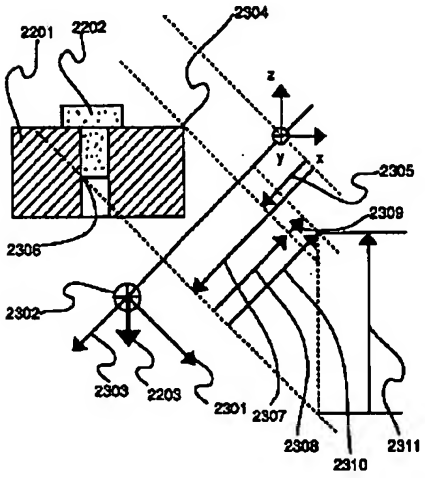


図 21

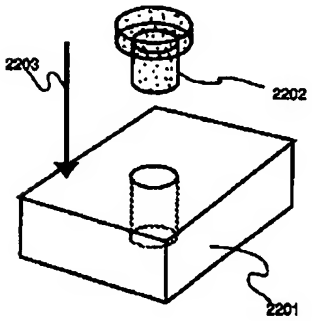
[Drawing 23]

図 23



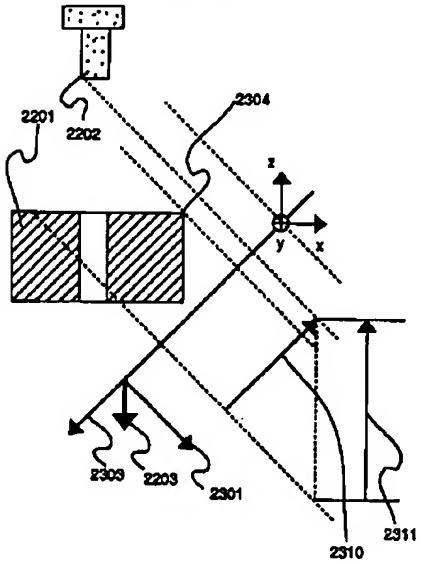
[Drawing 25]

図 25



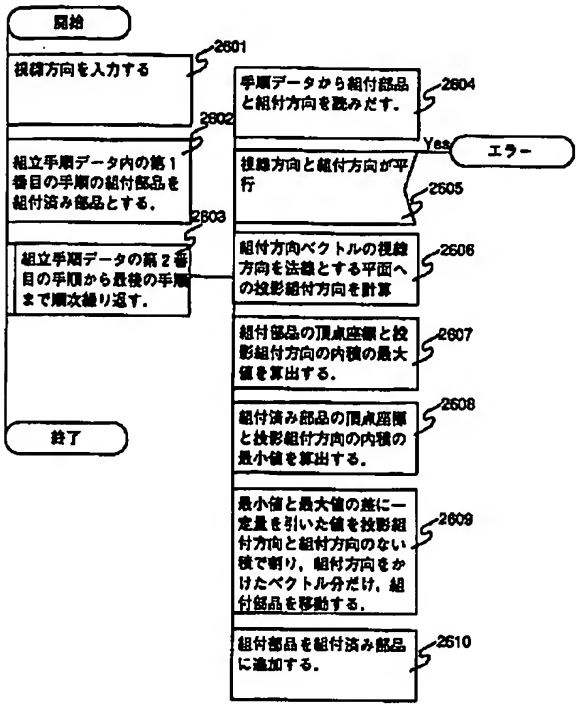
[Drawing 24]

図 24



[Drawing 26]

図 26



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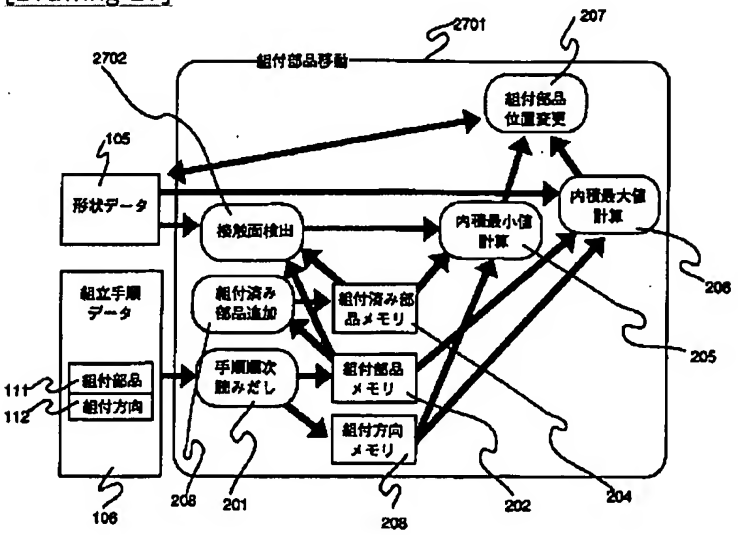
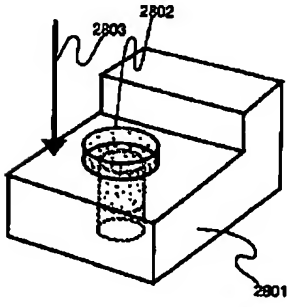


図 27

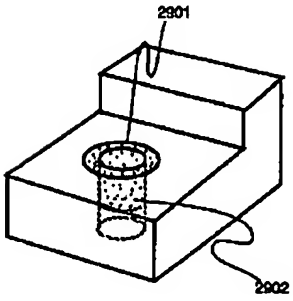
[Drawing 28]

図 28



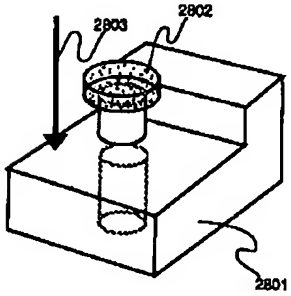
[Drawing 29]

図 29



[Drawing 31]

図 31



[Drawing 37]

図 37

手順ステップ	組付部品	組付方向
1	3601	—
2	3602	(0,-1)
3	3603	(-1,0)
4	3604	(0,-1)

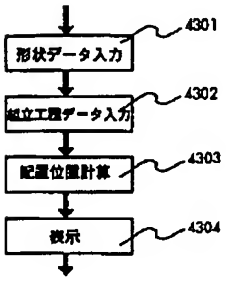
[Drawing 39]

図 39

手順ステップ	組付部品	組付方向
1	3601	—
2	3602	(0,-1)
3	3603	(0,-1) 3901
4	3604	(0,-1)

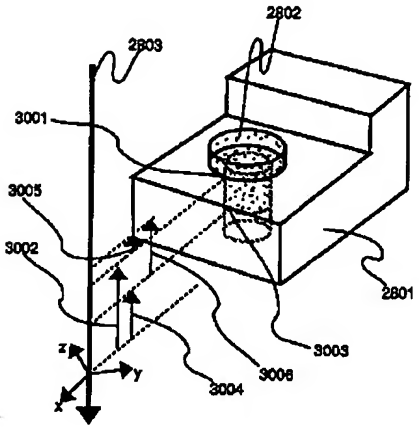
[Drawing 43]

図 43



[Drawing 30]

図 30



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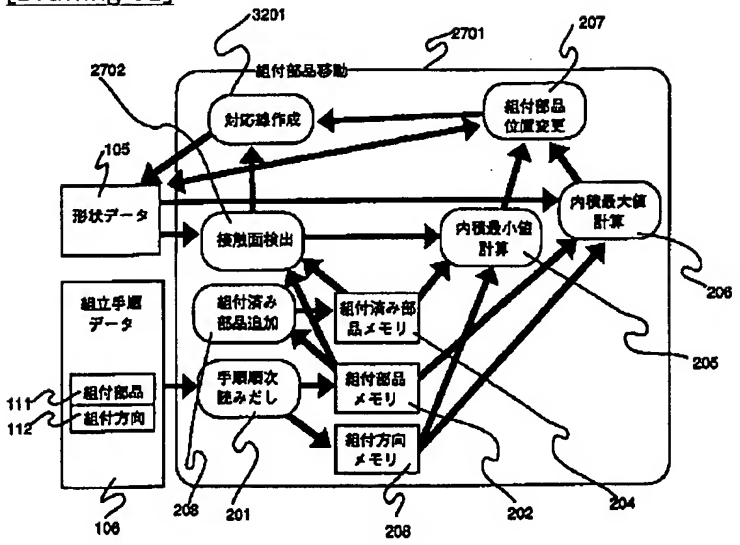
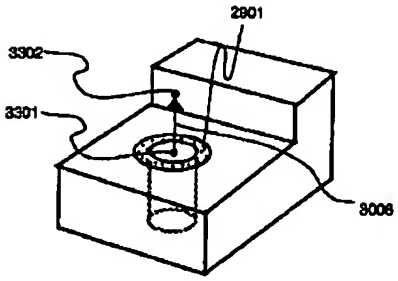


図 32

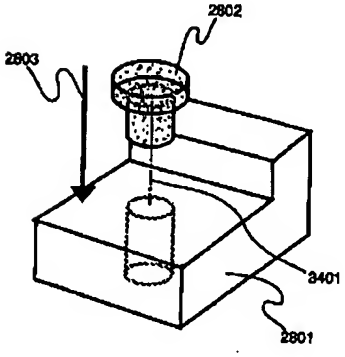
[Drawing 33]

図 33



[Drawing 34]

図 34



[Drawing 35]

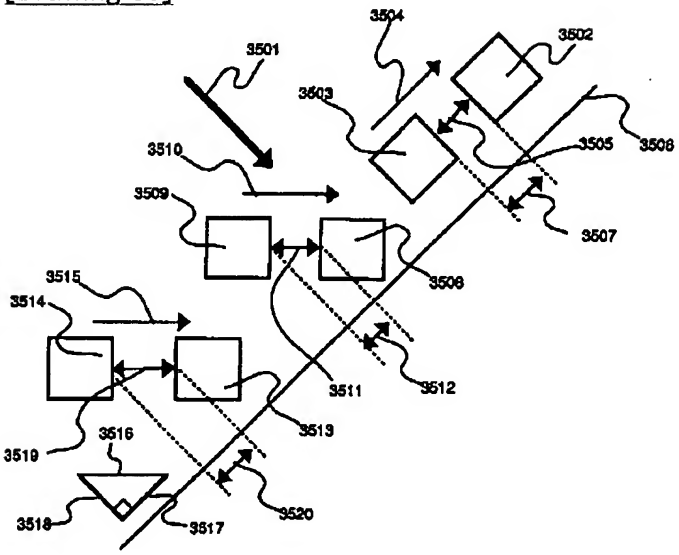
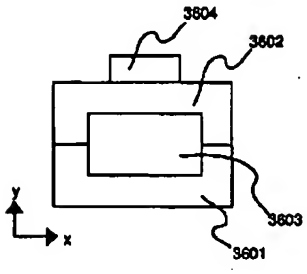


図 35

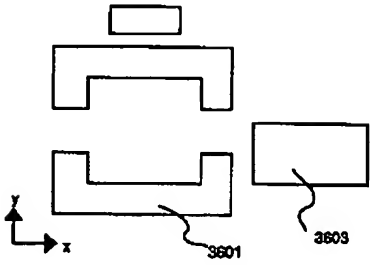
[Drawing 36]

図 36



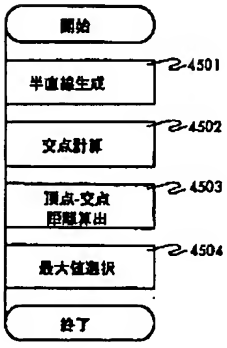
[Drawing 38]

図 38



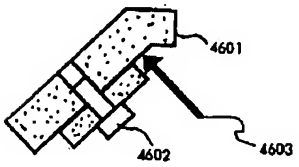
[Drawing 45]

図 45



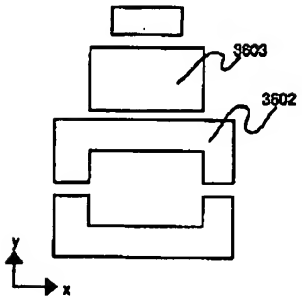
[Drawing 46]

図 46



[Drawing 40]

図 40



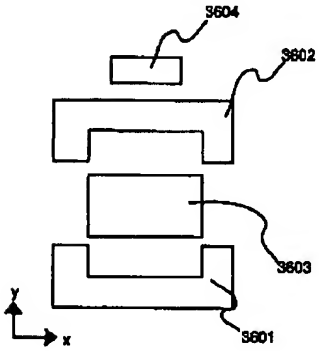
[Drawing 41]

図 41

手順ステップ	組付部品	組付方向
1	3601	—
2	3603	(0,-1) 4101
3	3602	(0,-1) 4102
4	3604	(0,-1)

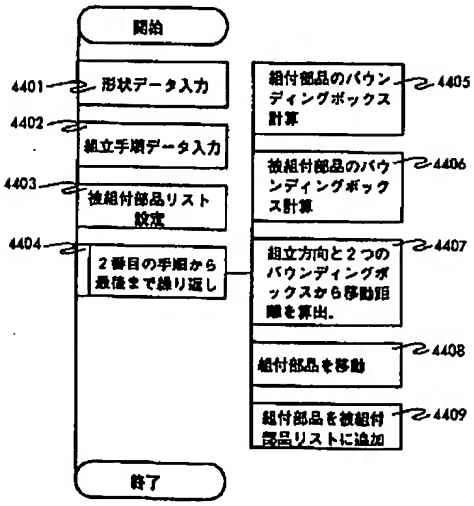
[Drawing 42]

図 42

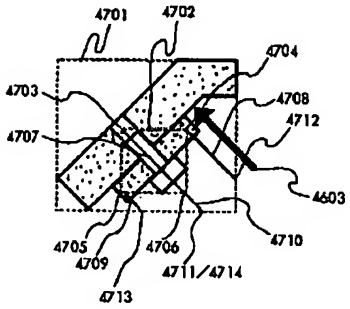


[Drawing 44]

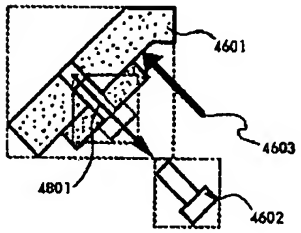
図 44



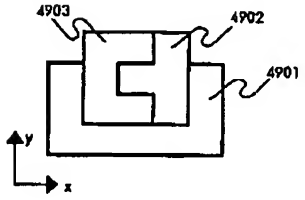
[Drawing 47]
図 47



[Drawing 48]
図 48



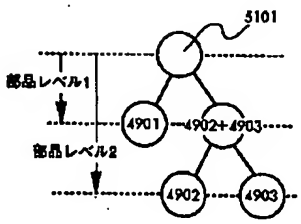
[Drawing 49]
図 49



[Drawing 50]
図 50

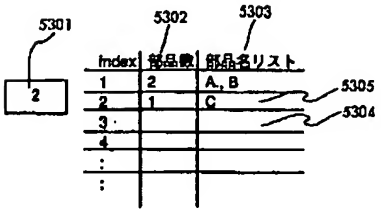
順序	組付部品	組付方向	部品レベル
1	4901		1
2	4903		2
3	4902	-X	2
4	4902+4903	-Y	1

[Drawing 51]
図 51



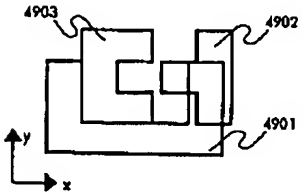
[Drawing 53]

図 53



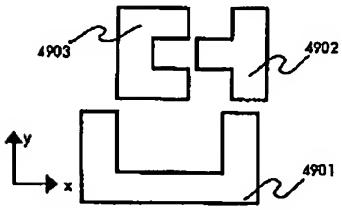
[Drawing 54]

図 54



[Drawing 55]

図 55



[Drawing 56]

図 56

順序	組付部品	組付方向	サブアッセンブリフラグ
1	4901		0
2	4904	-Y	1

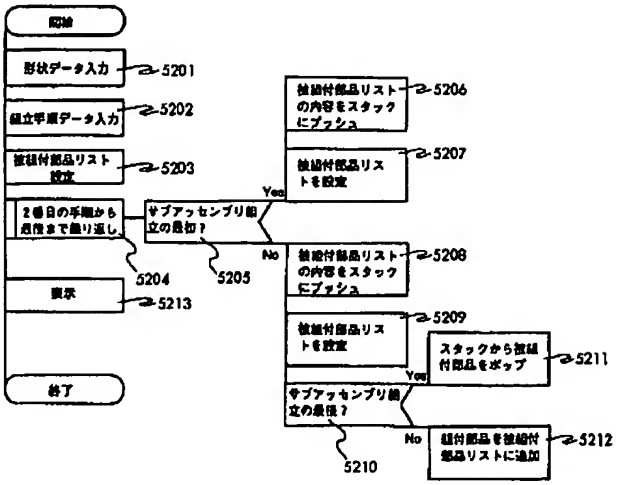
[Drawing 57]

図 57

順序	組付部品	組付方向	サブアッセンブリフラグ
1	4903		0
2	4902	-X	0

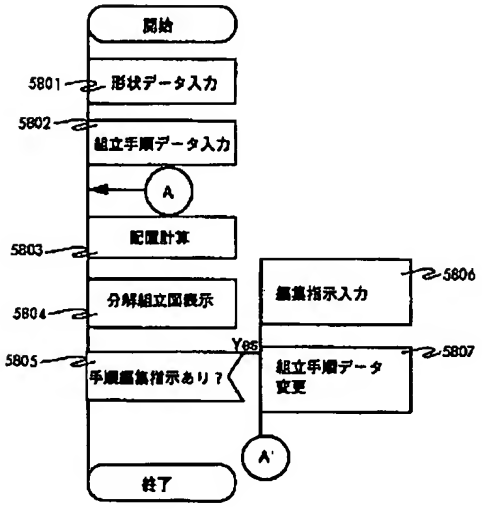
[Drawing 52]

図 52



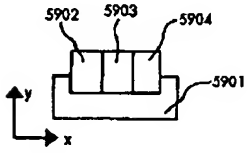
[Drawing 58]

図 58



[Drawing 59]

図 59



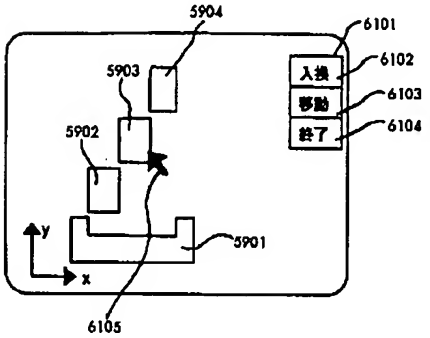
[Drawing 60]

図 60

順序	組付部品	組付方向
1	5901	-Y
2	5902	-Y
3	5903	-Y
4	5904	-Y

[Drawing 61]

図 61



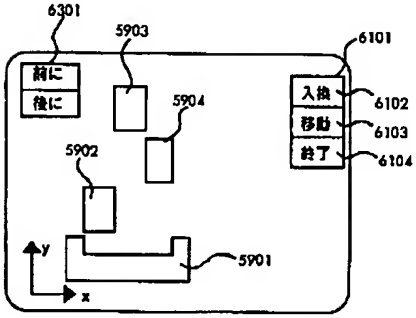
[Drawing 62]

図 62

順序	組付部品	組付方向
1	5901	-Y
2	5902	-Y
3	5904	-Y
4	5903	-Y

[Drawing 63]

図 63



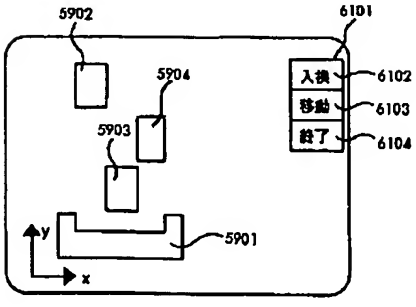
[Drawing 64]

図 64

順序	組付部品	組付方向
1	5901	-Y
2	5903	-Y
3	5904	-Y
4	5902	-Y

[Drawing 65]

図 65



[Translation done.]